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BANGS

& HARDAWAY

GENITO-URINARY

AND SKIN DISEASES

SYPHILIS

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AN AMERICAN TEXT-BOOK

OF

GENITO-URINARY DISEASES, SYPHILIS, AND DISEASES OF THE SKIN.

EDITED BY

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PREFACE.

THIS addition to the series of "AMERICAN TEXT-BOOKS" on Medicine and Surgery the Editors believe will meet the requirements of both students and practitioners, and will be found to be a comprehensive and detailed presentation of the Diseases of the Genito-urinary Organs, of the Venereal Diseases, and of the Affections of the Skin.

The vast accumulation and diversity of knowledge and the consequent subdivision of labor in modern science render co-operation necessary in works covering wide fields of observation and research; for thus only, as exhibited, we believe, in the present instance, can thoroughness, accuracy, and the results of a mature experience be obtained.

Having secured the collaboration of well-known authorities in the branches represented in this undertaking, the Editors have not restricted the contributors in regard to the particular views set forth in its pages, but have offered every facility for the free expression of individual opinion.

The book will therefore be found to be original, yet homogeneous and fully representative of the several departments of medical science with which it is concerned.

The text has been amply illustrated with typical portraits both in color and in black and white, and especial attention has also been paid to the reproduction of drawings made under the microscope. Many of the illustrations are original, being taken from the private collections of the authors; others have been borrowed, with proper acknowledgment, from various sources. In this matter, as well as in many other ways, the Editors are under especial obligations to the publisher, Mr. W. B. Saunders, for his generous liberality.

The Editors beg to acknowledge their deep sense of indebtedness to the eminent contributors to this work, without whose aid and encouragement it could not have been brought to a satisfactory conclusion, and to Dr. Chas. Langdon Gibson, Surgeon to St. Luke's Hospital, New York, and to Mr. Thos. F. Dagney, of Mr. Saunders' editorial rooms, for their critical and efficient assistance.

MEDICAL ASSOCIATION

CONTENTS.

GENITO-URINARY DISEASES AND SYPHILIS.

PAGE

URINE-ANALYSIS, AND A CONSIDERATION OF THE URINE IN SURGICAL DISEASES OF THE URINARY TRACT . . 17
By PAUL THORNDIKE, M. D.

DISEASES OF THE PENIS 46
By B. FARQUHAR CURTIS, M. D.

DISEASES OF THE MALE URETHRA 84
By G. FRANK LYDSTON, M. D.

DISEASES OF THE TESTICLE AND ITS COVERINGS, THE CORD, AND THE SEMINAL VESICLE 213
By EUGENE FULLER, M. D.

DISEASES OF THE PROSTATE 255
By J. WILLIAM WHITE, M. D., and ALFRED C. WOOD, M. D.

DISEASES OF THE BLADDER 337
By EDWARD MARTIN, M. D., and A. E. TAYLOR, M. D.

VESICAL CALCULUS 410
By FRANCIS S. WATSON, M. D.

DISEASES OF THE URETER 470
By CHRISTIAN FENGER, M. D., with the collaboration of S. C. STANTON, M. D.

THE SURGICAL DISEASES OF THE KIDNEY 543
By P. R. BOLTON, M. D.

FUNCTIONAL DISORDERS 593
By JAMES PEDERSEN, M. D.

ACQUIRED SYPHILIS 615
By JAMES S. HOWE, M. D.

SYPHILIS OF THE BONES, JOINTS, BURSÆ, TENDONS, AND MUSCLES 651
By LEWIS C. BOSHER, M. D.

SYPHILIS OF THE RESPIRATORY, CIRCULATORY, LYMPHATIC, AND ALIMENTARY SYSTEMS 665
By JO H. LINSLEY, M. D.

PAGE
SYPHILIS OF THE NERVOUS SYSTEM 690
By Græme M. Hammond, M. D., LL.B.

SYPHILIS OF THE EYE 700
By Thomas R. Pooley, M. D.

HEREDITARY SYPHILIS 722
By Abraham Jacobi, M. D.

TREATMENT OF SYPHILIS 735
By Robert Holmes Greene, A. M., M. D.

CHANCROIDS 757
By James S. Howe, M. D.

DISEASES OF THE SKIN.

PART I.—INTRODUCTION.

ANATOMY AND PHYSIOLOGY OF THE SKIN 765
By John T. Bowen, M. D.

GENERAL SYMPTOMATOLOGY 778
By Charles W. Allen, M. D.

GENERAL ETIOLOGY 782
GENERAL PATHOLOGY 784
GENERAL DIAGNOSIS 785
By Douglass W. Montgomery, M. D.

CLASSIFICATION 786
By W. A. Hardaway, M. D.

PART II.—SPECIAL.

CLASS I.—INFLAMMATIONS.

Erythema . . . . I. E. Atkinson, M. D. 789
Erythema Simplex . . . . “ 789
Symptomatic Erythema Simplex . . . . “ 791
Erythema Scarlatiniforme . . . . “ 792
Erythema Medicamentosum . . . . “ 792
Passive Hyperemia . . . . “ 793
Symptomatic Passive Hyperemia . . . . “ 793
Erythema Exudativum Multiforme . . . . “ 795
Erythema Nodosum . . . . “ 799
Erythema Induratum . . . . “ 801
Erysipelas . . . . C. W. Allen, M. D. 802
Erysipeloid . . . . “ 807
Pellagra . . . . “ 807
Aerodynia . . . . “ 808

		PAGE
Furuncle	C. W. Allen, M. D.	809
Carbuncle	"	811
Malignant Pustule	Douglass W. Montgomery, M.D.	814
Equinia	"	817
Dissection-wounds	"	821
Impetigo	Douglass W. Montgomery, M. D.	821
Impetigo Contagiosa	"	822
Ecthyma	"	823
Pompholyx	A. R. Robinson, M. D.	825
Herpes Simplex	James M. Winfield, M. D.	827
Herpes Facialis	"	827
Herpes Progenitalis	"	828
Zoster	"	829
Pemphigus	"	833
Impetigo Herpetiformis	"	838
Dermatitis Herpetiformis	"	840
Eczema	W. A. Hardaway, M. D.	843
Dermatitis Repens	"	877
Prurigo	Hermann G. Klotz, M.D.	877
Psoriasis	"	880
Pityriasis Maculata et Circinata; Pityriasis Rosea	"	889
Dermatitis Exfoliativa and Pityriasis Rubra	"	890
Dermatitis Exfoliativa Epidemica	"	894
Dermatitis Exfoliativa Neonatorum	"	895
Parakeratosis Variegata	"	896
Urticaria	"	897
Urticaria Pigmentosa	"	901
Angioneurotic Edema	"	902
Lichen Ruber	M. B. Hartzell, M. D.	903
Lichen Planus	"	906
Lichen Scrofulosorum	"	910
Lichen Pilaris	"	911
Pityriasis Rubra Pilaris	"	912
Dermatitis Factitia	"	915
Sphaceloderma	"	917
Dermatitis Medicamentosa	Joseph Grindon, M. D.	923
Dermatitis Venenata	"	929
Dermatitis Calorica	"	932
X-ray Dermatitis	"	934
Dermatitis Congelationis	"	935
Dermatitis Traumatica	"	935
Vaccinal Rashes	"	936

CLASS II.—HEMORRHAGES.

Purpura	John T. Bowen, M. D.	937

CLASS III.—HYPERTROPHIES.

Lentigo	J. Abbott Cantrell, M. D., and E. J. Stout, M. D.	945
Chloasma	" "	946
Anomalous Discoloration of the Skin and Mucous Membrane	" "	948
Acanthosis Nigricans	" "	948

PAGE
Tattooing . . . . J. Abbott Cantrell, M. D., and E. J. Stout, M. D. 949
Argyria . . . . " " 949
Keratosis Pilaris . . . . " " 950
Keratosis Senilis . . . . " " 950
Keratosis Palmaris et Plantaris . . . . " " 951
Angiokeratoma . . . . " " 952
Callositas . . . . " " 953
Clavus . . . . " " 953
Cornu Cutaneum . . . . " " 955
Verruca . . . . " " 955
Porokeratosis . . . . Joseph Grindon, M. D. 957
Papilloma Cutis . . . . J. Abbott Cantrell, M. D., and E. J. Stout, M. D. 958
Nævus Pigmentosus . . . . " " 959
Ichthyosis . . . . " " 960
Sclerema Neonatorum . . . . F. J. Shepherd, M. D. 962
Edema . . . . " 963
Scleroderma . . . . " 964
Elephantiasis . . . . " 970
Acromegaly . . . . " 975
Myxedema . . . . " 976

CLASS IV.—ATROPHIES.

Albinism . . . . Condict W. Cutler, M. D. 977
Leukoderma . . . . " 978
Atrophia Cutis Senilis . . . . " 980
Striæ et Maculæ Atrophicæ . . . . " 981
Perforating Ulcer of the Foot . . . . " 983
Glossy Skin . . . . " 984
Ainhum . . . . " 985

CLASS V.—NEW GROWTHS.

Cicatrix . . . . Jas. C. Johnston, M. D. 968
Keloid . . . . " 988
Fibroma . . . . " 990
Lipoma . . . . " 992
Myoma . . . . " 992
Neuroma . . . . " 993
Osteoma . . . . " 994
Molluscum Contagiosum . . . . S. Pollitzer, M. D. 994
The Xanthomata . . . . " 997
Angioma Serpiginosum . . . . " 1001
Darier's Disease and Protozoan Infection . . . . " 1002
Tumors and Malformations of the Blood-vessels . . " 1006
Lymphangioma . . . . " 1010
Leukokeratosis Buccalis . . . . " 1012
Xeroderma Pigmentosum . . . . R. W. Taylor, M. D. 1014
Rhinoscleroma . . . . Jas. M. Winfield, M. D. 1019
Tuberculosis Cutis . . . . Jas. C. Johnston, M. D. 1022
Lupus Erythematosus . . . . " 1035
Mycosis Fungoides . . . . J. A. Fordyce, M. D. 1040
Sarcoma Cutis . . . . " 1043
Leprosy . . . . Isadore Dyer, M. D. 1048
Morvan's Disease . . . . " 1056

PAGE
Colloid Degeneration of the Skin . . . . Isadore Dyer, M. D. 1058
Adenoma Sebaceum . . . . " 1059
Adenoma of the Sweat-glands . . . . " 1061
Multiple Benign Cystic Epithelioma . . . . " 1062
Carcinoma Cutis . . . . A. R. Robinson, M. D. 1064
Epithelioma . . . . " 1065
Paget's Disease . . . . " 1073
Frambesia . . . . H. Tuholske, M. D. 1074
Verruga . . . . " 1076
Aleppo Boil . . . . " 1077
Tropical Ulcer . . . . " 1079

CLASS VI.—NEUROSES.

Hyperesthesia . . . . A. Van Harlingen, M. D. 1079
Pruritus . . . . " 1081
Dermatalgia . . . . " 1085
Anesthesia . . . . " 1086

CLASS VII.—DISEASES OF THE APPENDAGES OF THE SKIN.

A. DISEASES OF THE SWEAT-GLANDS.

I. FUNCTIONAL DISORDERS.

Hyperidrosis . . . . Louis Heitzmann, M. D. 1087
Anidrosis . . . . " 1089
Bromidrosis . . . . " 1089
Chromidrosis . . . . " 1090
Uridrosis . . . . " 1091

II. ORGANIC AFFECTIONS.

Hidradenitis Suppurativa . . . . Louis Heitzmann, M. D. 1091
Miliaria and Sudamina . . . . A. R. Robinson, M. D. 1092
Hidrocystoma . . . . " 1096
Miliary Fever . . . . " 1098

B. DISEASES OF THE SEBACEOUS GLANDS.

Seborrhea . . . . Louis Heitzmann, M. D. 1099
Eczema Seborrhoicum . . . . " 1105
Asteatosis . . . . " 1109
Comedo . . . . " 1109
Milium . . . . " 1111
Steatoma . . . . " 1111
Acne Disseminata . . . . " 1112
Acne Rosacea . . . . " 1118
Acne Varioliformis . . . . " 1122

C. DISEASES OF THE HAIR-FOLLICLES.

Canities . . . . G. T. Jackson, M. D. 1123
Discolorations of the Hair . . . . " 1124
Hypertrichosis . . . . " 1124
Atrophia Pilorum Propria . . . . " 1127
Plica Polonica . . . . " 1129
Piedra . . . . " 1129
Beigel's Disease . . . . " 1129
Tinea Nodosa . . . . " 1129

PAGE
Lepothrix . . . . G. T. Jackson, M. D. 1130
Alopecia . . . . " 1130
Alopecia Areata . . . . " 1134
Folliculitis Decalvans . . . . " 1137
Dermatitis Papillaris Capillitii . . . . " 1138
Conglomerate Suppurative Perifolliculitis . . . . " 1139
Sycosis . . . . " 1140

D. DISEASES OF THE NAILS.

Onychauxis . . . . H. N. Lyon, M. D. 1143
Atrophia Unguium . . . . " 1144
Onychia . . . . " 1144
Onychomycosis . . . . W. T. Corlett, M. D. 1145
Leukopathia Unguium . . . . H. N. Lyon, M. D. 1147
Scleronychia . . . . " 1147
Spoon-nail . . . . " 1147
Reedy Nail . . . . " 1148
Pterygium . . . . " 1148

CLASS VIII.—PARASITIC DISEASES.

A. VEGETABLE.

Vegetable Parasitic Diseases . . . . W. T. Corlett, M. D. 1148
Tinea Favosa . . . . " 1148
Tinea Trichophytina . . . . " 1157
Tinea Circinata . . . . " 1158
Tinea Tonsurans . . . . " 1162
Tinea Barbæ . . . . " 1172
Tinea Imbricata . . . . " 1176
Podelcoma . . . . " 1179
Actinomycosis of the Skin . . . . " 1181
Tinea Versicolor . . . . " 1183
Erythrasma . . . . " 1187
Mal del Pinto . . . . " 1188

B. ANIMAL.

Scabies . . . . A. E. Regensburger, M. D. 1189
Phtheiriasis . . . . " 1196
Demodex Folliculorum . . . . " 1200
Filaria Medinensis . . . . " 1200
Animal Parasites of Minor Dermatological Importance . . . . " 1201

GENITO-URINARY DISEASES

AND

SYPHILIS.

URINE-ANALYSIS,

AND A CONSIDERATION OF THE URINE IN SURGICAL DISEASES OF THE URINARY TRACT.

By PAUL THORNDIKE, M. D.

Any attempt to write an exhaustive article on urine-analysis and to confine it within the limits of a treatise of this length would be useless. In the present pages, therefore, the characteristics and chemical constituents of urine, and the commoner and more practical methods for investigating them, will be described. The significance of the pathological conditions of urine found in the various disorders of the urinary tract will be briefly considered. More than this cannot be attempted.

Urine is a watery solution of the products of tissue-metabolism in the body. In health it varies in its characteristics only within certain limits, and is a clear, yellow liquid of acid reaction, slight characteristic odor, and a specific gravity of 1015 to 1025, taking water as the standard at 1000. Healthy people pass about 1500 cubic centimeters—that is, about 40 to 60 ounces—of urine in each twenty-four hours, the amount being greater during the waking than the sleeping hours. The amount passed by a healthy individual is, of course, readily affected by outside causes, such as the amount of fluid taken into the system; the condition of weather and climate, which affects the evaporation of moisture from the skin; and by any condition of the body which affects the blood-supply of the kidneys. It is commonly said that about one-half the total amount of the fluids excreted from the body pass through the kidneys, and the other half through the skin, bowels, and lungs. This is probably practically true, and of course any condition or disease which calls an extra amount of fluid to another part of the body diminishes the amount of urine. For example, exercise in hot weather greatly increases the activity of the skin and so diminishes the urine in amount. Diarrhœa with a large number of liquid stools diminishes the amount of the urine. In dropsical conditions the same is true, the amount of urine diminishing as the dropsy increases, and *vice versâ*.

In the acute stage of fevers the urine is diminished, gradually increasing as the fever abates, and often passing beyond the normal limit before settling down to the routine amount of health. After surgical operations upon the abdominal organs the amount of urine is often very markedly decreased, sometimes to the point of complete suppression. In such cases it is of the utmost importance to watch the amount secreted, and this is generally a pretty accurate indication of the degree of shock which the patient has sustained. This is, perhaps, especially true of operations on the genito-urinary organs. In watching the amount secreted it is of course necessary to take care not to miss the urine passed at the time the bowels are moved, and, also, that the urine should be measured and not guessed at. In almost any disease terminating fatally, and where the decline in health is gradual, the amount of urine decreases as death approaches.

There are various conditions, both of the kidney and of other parts of the body, where the amount of urine is uniformly increased. Among the former may be mentioned the chronic forms of nephritis, especially those where the interstitial element predominates, and amyloid kidney. Among the latter are cerebral hemorrhage from any cause, traumatic or otherwise (here the amount of urine is often very large and sugar is found present in about half the cases); diabetes mellitus, although in this disease the amount may be little, if any, above normal; diabetes insipidus, which is the name given to an indefinite class of cases characterized by nervous symptoms and a urine where both the amount and the solids for each twenty-four hours are more or less largely increased.

In fact, the nervous system often has a very marked effect upon the activity of the kidneys. People in a condition of temporary nervous excitement, as well as people suffering from various forms of hysteria and nervous debility, often pass very large quantities of urine. The condition spoken of as phosphaturia is very often a condition of nervous debility and exhaustion, accompanied by a watery, pale urine of weak acidity and low specific gravity.

Density.—The normal urine is generally of a specific gravity of 1015 to 1025: 1021 is about the healthy average, and anything over this, if constant, is apt to prove irritating to the mucous membranes of the urinary tract. The temporary increase or decrease in this density is so easily produced as to make such changes of no importance clinically. If, however, an increase above or a decrease below such a density is permanent, it demands investigation. The relation between the volume and the density of a urine is so close that the investigation of one means the investigation of the other, as it helps a physician very little in many cases to know the specific gravity if he does not know the twenty-four hours' amount. The specific gravity is so easily taken, and the amount is so much more troublesome to measure, that we are rather accustomed to estimate the latter from a knowledge of the former.

A very simple, and therefore important, way to estimate the amount of solids present is to multiply the last two figures of the specific gravity as recorded by the urinometer by $2\frac{1}{3}$. This gives the amount of solids in grams in 1 liter of urine. This is of course important with relation to the total amount of urine passed.

A small amount of urine of a low specific gravity means the excretion of a small amount of solids, due, of course, either to decreased metabolism or to the ingestion of small amounts of food. If this condition exists together with kidney trouble, it means look out for uremic symptoms. The reverse of this condition—that is, a small amount with a high specific gravity—means concentration from diminished fluid elements.

This is most commonly found after hard exercise in people who drink but little water and in the early stages of acute diseases. It is easy to decrease the specific gravity and increase the amount of urine by taking certain diuretic drugs. This condition—that is, a large amount of urine of a low specific gravity—often exists in convalescence from acute diseases or in the decreasing stage of a dropsical condition. If due to a renal affection, it is most commonly a chronic interstitial nephritis or the convalescence from a very acute nephritis just before the kidneys have re-established themselves in the customary routine of their work. If the quantity and specific gravity are both large, it means, usually, either diabetes mellitus or the condition known as diabetes insipidus, where both amount and solids are increased.

Color.—The color of urine is usually spoken of as *pale*—that is, colorless to pale yellow; *normal* or amber color; *high* or yellow brown; and *dark*. The first three may be normal urines; the other is never so. The pale urine means an increase in watery elements, and is usually large in amount, but of low specific gravity. If constant, it suggests some affection such as diabetes mellitus or insipidus, where the amount for twenty-four hours is regularly increased.

High-colored urine means concentration. It is usually less in volume than normal, and, if constant, suggests that the urine may be irritating in character and needs dilution. The dark color of urine is generally due to the presence of blood or bile, more rarely to the effects of some drug, generally carbolic acid or, occasionally, rhubarb or senna.

The urines of people suffering from melanotic cancer sometimes take on a dark-brown color after standing for a time, thereby setting free some dark pigment. In the same way urines in cases of carbolic-acid poisoning grow darker the longer they are left standing. In cases of hematuria the color depends upon the seat of the hemorrhage and the length of time the specimen is left standing. If the hemorrhage is from the bladder or urethra, one gets a bright-red color, while if it is from the pelvis or tubules of the kidney, the urine is of a higher-colored red; and, again, the longer the urine stands the darker and less red-looking it becomes. Of course the shade of color also depends upon the quantity of blood present, as a small amount gives only a smoky look to the urine. As the amount increases the urine gets blacker and blacker looking. Blood in the urine is, of course, most easily seen with the microscope, but, occasionally, we find cases where there is no blood present, the urine being colored by blood-pigment. That is to say, these are cases of hemoglobinuria as contrasted with hematuria. No blood-corpuscles are present, the pigment being free in the urine.

These cases are rare, and are usually found in conditions like typhus fever or scurvy, where there is much disintegration of blood-corpuscles. The spectroscope demonstrates this condition best, but if a little of such urine be acidified with a few drops of acetic acid and boiled, a brown precipitate forms. Bile in the urine usually gives a color which varies from a greenish-yellow to a reddish-brown according to whether the bile-pigments are decomposed or not. Such urines nearly always form a greenish-yellow foam on the surface if they are shaken. If a little urine which contains bile be put on a porcelain surface (white), and a drop of nitric acid added to it, the presence of bile is demonstrated by a beautiful play of colors from green, through blue and red, to yellow.

Reaction.—Healthy urine is usually slightly acid in reaction, chiefly because of the acid salts which it contains, and which it is the work of the kidneys to separate from the blood. The reaction is best tested by dipping small strips of blue litmus-paper part way into the urine, and contrasting the undipped portion with the acid red of the part which is wet with urine. The lack of the red acid reaction is usually sufficient evidence of lack of acidity in the urine.

A very acid urine usually means a very concentrated one, from the abundance of the salts which it contains. Whenever the acidity of the blood is diminished by a vegetable diet or by the administration of alkaline drugs, the urine becomes mildly acid or even alkaline to a corresponding degree, and this explains why the urine is often temporarily alkaline after a solid meal.

In certain diseases accompanied by extreme debility the urine is often kept in a faintly acid or alkaline condition for considerable periods of time, probably because of the excessive elimination of alkaline carbonates.

This is often true in anemias, wasting diseases like pulmonary phthisis, nervous debility, etc., and gives rise to a condition commonly but improperly spoken of as phosphaturia, because the alkaline or faintly acid urine is more or less constantly clouded with the precipitate of phosphates.

True phosphaturia—that is, a real increase in the twenty-four hours' amount of phosphoric acid eliminated—is a very rare condition. If a urine is alkaline from decomposition, it means either that it has decomposed while standing or that the decomposition has taken place in the bladder by reason of bacteria introduced from without, and generally by unclean instruments. If care be taken to have the specimen voided into a perfectly clean vessel, it will often keep for days without decomposing, although urines vary in this respect.

If a urine containing pus is found to remain acid for days without beginning to decompose, it should at once suggest that the pus comes from the pelvis of the kidney, as the urines of bladder-disease rarely keep fresh for any length of time.

Transparency.—Normal urine is always clear when passed, but of course many clear urines are not normal. A few minutes after being passed a slight cloud of mucus and epithelial elements may be seen suspended in the fluid. If the urine is cloudy when passed, it means, usually, either *pus* or *phosphates*, more rarely *bacteria*, which may be present in large numbers, with little or no pus, or very much more rarely still a condition known as *chyluria*, which is a milky appearance of the urine caused by minute fat-globules suspended in it. This condition will be considered more at length elsewhere.

If the cloudiness be due to phosphates, a few drops of acetic acid will clarify the urine at once. Free pus settles quickly to the bottom of the glass, leaving the urine clear above it. It can be readily demonstrated with the microscope. Bacteria make a slight, filmy turbidity which is unchanged after standing, showing no tendency to settle. It must be remembered in this connection that some urines, clear when passed, throw down a cloud of amorphous urates as soon as the urine has had a few minutes in which to cool. The turbidity thus produced may be quickly dispelled by a little heat, care being taken that the heat does not prove potent enough to replace the cloud of urates by one of albumin. Decomposed urine always becomes turbid on standing, and is coated over with an iridescent film of triple phosphates.

Odor.—Of the odor of urine little need be said. The ammoniacal odor due to the decomposition of urea is familiar. Sometimes there is associated with it the odor of sulphuretted hydrogen, due to the pus or albuminous matter in the decomposing urine. The only other odors of importance are those due to drugs, such as copaiba, cubebs, sandalwood oil, carbolic acid, turpentine, etc. The characteristic smell of asparagus in the urine is familiar to all.

CHEMICAL CONSTITUENTS, NORMAL AND ABNORMAL.

Urea.—The kidneys throw off a large percentage of the waste products that result from the metabolism of the tissues of the body. The process of combustion that produces these waste products is not always perfectly carried out, so that, instead of having one waste product as its result, we may have any one or more of a series of them.

Urea, which is the chief and by far the most important chemical constituent of the urine, is a white crystalline solid of neutral reaction, and so soluble that its crystals are never seen in the urine. Crystals of it may occasionally be seen on the skin, especially in the axilla after death from uremia. It represents the final product of tissue-combustion, and there may be found with it uric acid, oxaluric acid, xanthin, kreatinin, sarcin, and so on, all of which are products of the less complete oxidation of tissue. With many of these we need not concern ourselves, but uric acid and one or two others demand consideration.

Urea, then, is the chief representative of the waste material of the body, and therefore its amount fairly represents the amount of this waste, and so the amount of combustion itself. The quantitative amount of the urea, then, is often of the greatest importance. The amount secreted in the urine by healthy people under ordinary conditions of life is about 25 to 40 drams in each twenty-four hours, but this varies to a considerable degree with circumstances. It is increased by anything which increases the metabolism of tissue, such as increased ingestion of animal food and increased exercise, mental or physical. Pathologically, in the same way it is increased by any condition which promotes combustion of tissue. In acute fevers, for instance, the amount will sometimes go as high as 60 drams, or, occasionally, even to 80 drams, in twenty-four hours, and, as the ingestion of food in such conditions is usually decreased, this increase of the products of combustion nearly all comes from the tissues themselves.

In acute disease accompanied by dropsy—for example, acute nephritis—part of the urea is eliminated in the dropsical fluid, and so, as this fluid increases in amount, the quantity in the urine may be correspondingly diminished. This is also true in acute diarrheal troubles. In health free perspiration may eliminate urea from the blood to an extent perceptibly affecting its amount in the urine.

If the urea in the blood is not eliminated from the body properly, it gradually accumulates until it gives rise to symptoms indicating its presence in quantity. These symptoms are rather loosely spoken of as a condition of uremia, and it is, of course, in this connection that the quantitative amount of urea excreted is of importance to us clinically, for by frequent such estimates the cause of the disease and the effect of treatment upon it may be judged with some accuracy.

In making such an estimate the urine for the whole twenty-four hours should be mixed and tested, as, with the varying conditions of food and sleep, the amount of urea varies considerably at different times in the day. The various methods for quantitative estimates of urea are so elaborate as to place them practically out of the reach of the practitioner of medicine.

Dr. Charles Doremus of New York has a practical bromine method which can be carried out by means of his ureometer (Fig. 1), made and sold, with instructions for its use, by Eimer & Amend of New York. The writer has no personal experience with this method, and will therefore quote the various directions and suggestions with regard to it made by Dr. Eugene Fuller of New York in a recent paper on urine-analysis:

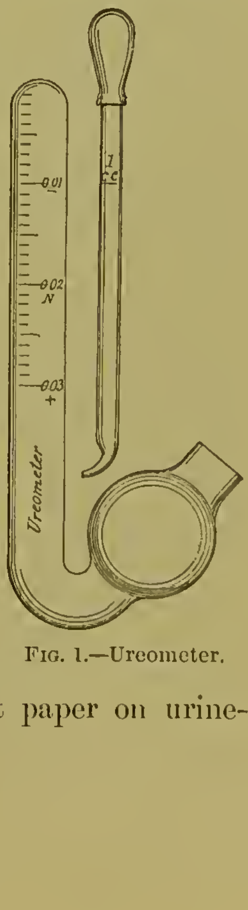

FIG. 1.—Ureometer.

"*Reagents Necessary.*—The sodium-hydrate solution (100 grams to 250 cubic centimeters of water, or 6 ounces to 1 pint of water) will keep indefinitely when tightly stoppered. Bromine, 25 cubic centimeters added to the above amount of sodium-hydrate solution, will make the concentrated hypobromite-of-sodium solution. This solution does not keep very well; so, if but few tests are to be made, it is well to make up but a small amount, observing these proportions. The bromine may be removed from the bottle in which it is kept by means of the metal pipette. One cubic centimeter of bromine suffices for a test. More can be removed if a quantity of hypobromite is to be made up. Some care must be exercised in handling the bromine, since it gives off irritating fumes; but by the above method of procedure no inconvenience ought to be experienced.

"This concentrated hypobromite must be diluted with its own volume of water. This can be done approximately.

"The long arm and the bend of the ureometer must be filled with the hypobromite.

"Having washed the pipette, draw up exactly 1 cubic centimeter of urine; pass the pipette through the bulb of the ureometer as far as it will go in the bend; compress the nipple *gently* and *steadily*. The urine will rise through the hypobromite, and the urea will instantly decompose, giving out nitrogen gas.

"Withdraw the pipette after the urine has been expelled, taking care not to press the nipple hard enough to drive the air out after the urine, and read the volume of gas after allowing the froth to subside. The ureometer indicates, according to its graduation, either the milligrams of urea in 1 cubic centimeter of urine or the grains of urea per fluidounce of urine.

"It also indicates by the signs + and — on either side of the central division whether the urea is present in a normal quantity or is increased or diminished.

"When the total quantity voided in twenty-four hours is known, the calculation of the amount of urea is very simple. Multiply the result found in milligrams by the number of cubic centimeters voided, or the grains per fluidounce by the number of ounces voided.

"The percentage by volume, or the milligrams of urea per 100 cubic centimeters of urine, is ascertained by multiplying the milligrams of urea found by the test by 100.

"Lowering the ureometer into a vessel of water until the water and hypobromite inside and that outside the graduated limb are on a level will give a more correct reading. The ureometer is graduated for 65° F., and upon an experimental basis.

"It is well to impress the fact that only those urines which have not undergone decomposition are available for accurate estimations of the quantity of urea, for, as has been previously noted in such conditions, urea is rapidly converted into carbonate of ammonium."

Uric Acid.—Uric acid, although the product of incomplete oxidation of tissue, is found in a small quantity in all urines, and it is only when it occurs in comparatively large amounts that it is of importance clinically. In the latter instance, if the urine is allowed to stand for a few hours, the uric acid can often be seen by the unaided eye as a red brick-dust deposit in the bottom of the vessel. In health it should be in solution in the urine, and, as it is only slightly soluble in water, it must combine with a basic salt to form urates in order to keep in solution. These urates, if present in any amount, usually cloud the urine after it has been standing for a few hours, and appear as a white or reddish-white sediment visible to the eye. They are much more soluble in warm than in cold water, and are readily redissolved after precipitation by the addition of hot water to the urine.

This deposit of urates comprises the acid urates of sodium, potassium, and ammonium, and is usually amorphous in character, although occasionally hedgehog crystals of urate of ammonium may be seen in clumps. It is these crystals which often form the nucleus of calculi in children. Urates are often constituents of calculi, and their significance in the urine is often much the same as the uric acid itself.

The uric acid tends to deposit itself from a normal urine after standing ten or twelve hours; then it may be seen in crystalline form both with the unaided eye and with the microscope. The crystals are always colored, but may be of a light-yellow or a deep reddish-brown, or of any color between these two extremes. The size, shape, and arrangement of the crystals vary greatly, the common shapes being pointed oval, lozenge, and dumb-bell crystals; they all tend to arrange themselves in queer kaleidoscopic masses (see Fig. 2). It is this strong tendency to combine in masses which makes uric-acid calculi so common.

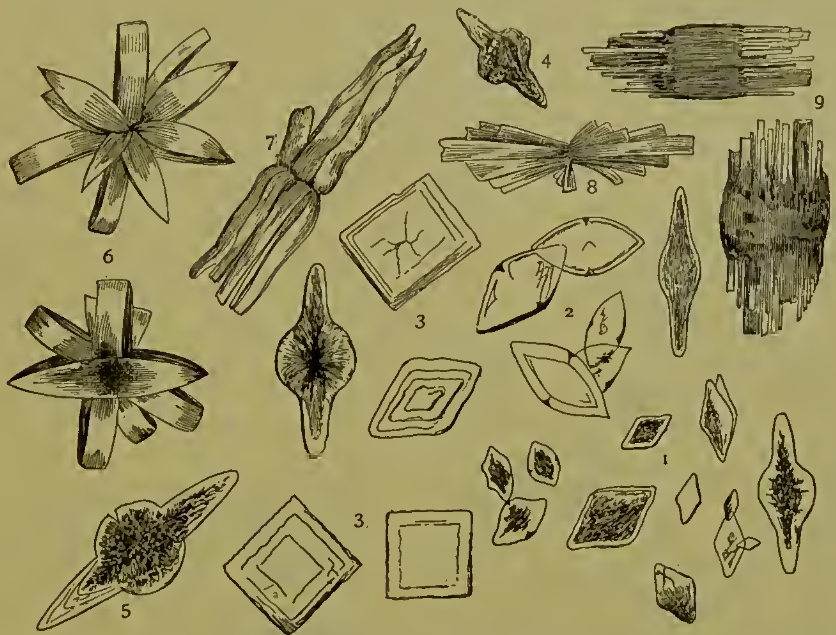

FIG. 2.—Forms of uric acid: 1, rhombic plates; 2, whetstone forms; 3, quadrate forms; 4, 5, prolonged into points; 6, 8, rosettes; 7, pointed bundles; 9, barrel forms precipitated by adding hydrochloric acid to urine.

Uric acid in excess, then, is found in the system in any condition which interferes with perfect oxidation of tissue. Such conditions are commonly certain affections of the nervous system resulting from mental or physical exhaustion; anemias; chronic gastric diseases; some acute febrile diseases; gout and rheumatism. People who are large eaters and take too little habitual exercise often have an excess of uric acid in their system.

Of course, in attempting to treat such conditions the cause must be found and treated. In acute rheumatic conditions we find no increase, and oftentimes even a decrease, of uric acid in the urine during the paroxysms of the disease, and a gradual increase up to far beyond the normal after the paroxysm has passed.

In testing for uric acid various methods may be pursued. A little urine in a watch-glass can be acidified with hydrochloric acid, and after standing over night crystals will be seen on the sides and bottom of the glass and on the surface of the fluid. This test implies experience in knowing from the quantity of the crystals present whether the uric acid is increased in amount or not. In the same way, blood-serum can be tested for uric acid by separating out the albumin and then acidifying the residual filtrate in a watch-glass, and letting crystals of uric acid collect on a bit of silk thread immersed in the solution. Here, again, experience is necessary.

The classic test for uric acid is called the murexid test, and is the one commonly used in testing calculi, as it will detect either uric acid or urates. It is as follows: Evaporate the fluid to be tested in a white porcelain dish over a water-bath; add a few drops of nitric acid and evaporate again; then add a drop or two of ammonia, and you get a beautiful purple-red color (murexid), and crystals are deposited after standing a time. These crystals reflect light of a cantharides-green color.

Calcic Oxalate.—Oxalic acid is another product that is formed as an intermediate step in the combustion process, and comes between urea and uric acid in the series. It is found in very small quantities in normal urine in the form of calcic oxalate, but it is contained in normal specimens only occasionally and after the urine has been left standing for a time.

It is fair to say that any urine containing more than a crystal or two of calcic oxalate for any length of time is not the urine of a healthy individual, and the condition is one that should be treated. Calcic oxalate occurs in urinary sediments in the form of octahedral (envelope-shaped) crystals (Figs. 3 and 4), which are so easily seen and so characteristic that no further test for them is necessary. Occasionally dumb-bell-shaped, oval, or round crystals are seen, the last named being rare and sometimes mistaken for a blood-corpuscle. They are so much more refractive that the mistake is not a common one.

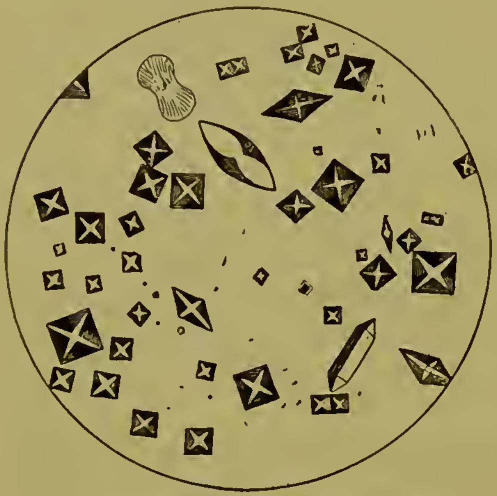

FIG. 3.—Calcium oxalate (Laache).

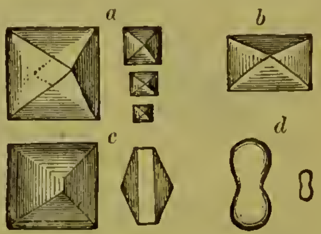

FIG. 4.—Oxalate of lime: *a*, *b*, octahedra; *c*, compound forms; *d*, dumb-bells.

Oxaluria is only a symptom pointing to a debilitated condition of the system, and of the cause of this condition little is known. Oxaluria is most often associated with conditions of nervous debility, perhaps especially often with those cases of debility arising from sexual excesses. So the urines of patients suffering with true spermatorrhea are very apt to contain crystals of calcic oxalate. This is so frequently the case that one should always be on the look out for spermatozoa if, in examining the urine of a nervous patient, he finds calcic oxalate present.

In addition to the nervous condition which is always an accompaniment of oxaluria, we generally have symptoms due to the mechanical irritation of the mucous membranes of the urinary tract by the crystals in the urine; so there is usually vesical tenesmus and pain across the back, even extending down the thighs and into the testicles. If the oxaluria is marked, we may have a good deal of a deposit in the kidneys, and so a bloody urine with renal epithelium and renal and blood casts in the sediment. If the condition lasts for any length of time, there is usually calculus-formation, the calculi commonly containing uric acid as well as calcic oxalate.

The treatment of this condition, aside from the treatment of the nervous system, is to promote the solution of the calcic oxalate in the urine by giving mineral-acid tonics. Claret and effervescent drinks should be avoided, also the ingestion of the vegetable rhubarb, which contains a good deal of oxalic acid.

Cystine.—Cystine is still another of the intermediate products of the combustion of nitrogenous substances. It occurs in small quantities in solution in normal urines, but when it occurs in pathological quantities it is deposited in the form of yellow six-sided crystals that are characteristic (Fig. 5). It is of interest clinically only because it commonly forms a small yellow calculus, usually soft, but sometimes hard if the cystine is present in combination with uric acid. To test such a calculus dissolve a portion in hydrate of potash; add a little plumbic-acetate solution and boil, getting a black deposit of the sulphate of lead, owing to the large amount (25 per cent.) of sulphur which cystine contains.

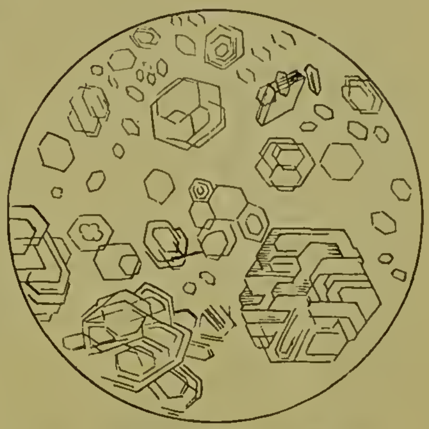

FIG. 5.—Crystals of cystine (after Ultzmann).

Indican.—Indican is in small quantities a constituent of normal urine, and occurs pathologically in much larger amounts. It has, in the past, been considered of great diagnostic importance, and much has been written of its clinical significance, especially by French authors. It is made by the union of indigo-blue with sugar, and is formed chiefly in the upper intestine during the process of digestion. Any cause which interferes with the proper function of the intestine and prevents the absorption of the products of the first part of digestion gives rise to a marked increase in the amount of indican in the urine. This is especially true of obstructive diseases of the bowels and other abdominal viscera—*e. g.* new growths and hernia with some obstruction of the bowel. Peritonitis, cholera, and cirrhosis of the liver are other diseases associated with increased amounts of indican.

On finding such an increase in any specimen of urine, the diagnostician should be cautious in ascribing too much importance to it, for indican is often found in increased amounts in the urines of nervous people suffering from functional digestive disturbances. In testing for indican the reaction of Heller gives a very easy demonstration, and is quite delicate enough to show small amounts of indican.[1] Three or four cubic centimeters of strong hydrochloric acid are mixed with 30 or 40 drops of urine in a test-tube, and if indican is present one gets a color varying from reddish-violet to an intense blue according to the amount present. If a few drops of strong nitric acid are added, the test is still more delicate, and in the course of a few minutes one gets a violet-colored reaction.

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[1] See Neubauer and Vogel, 7th ed. (translated), p. 71.

Chlorides.—Chlorides are found in normal urine in considerable quantities, chiefly as the chloride of sodium. They are occasionally of importance to the general practitioner from the fact that in certain acute diseases (notably in pneumonias) they are much decreased in amount. Aside from this, they are rarely of diagnostic importance. They may be demonstrated in an acid urine by adding to it, drop by drop, a solution of nitrate of silver, thereby precipitating a thick white cloud of argentic chloride.

Sulphates.—The sulphates normally present in urine are of little clinical importance, and do not demand consideration in a chapter of this character.

Phosphates.—Phosphoric acid is present in the urine in combination with potassium, sodium, calcium, and magnesium in the form of phosphates. The phosphates of sodium and potassium (alkaline phosphates) are very soluble, and therefore are never precipitated from the urine. The phosphates of calcium and magnesium (earthy phosphates) are of clinical importance, as in many conditions of the system, both in health and disease, they are precipitated from the urine, and are often associated with symptoms of much importance and demanding careful consideration.[1] These urines, turbid with precipitated phosphates, are generally associated with nervous conditions and digestive disturbances. The turbidity at once disappears by the addition of a few drops of acetic acid to the urine. Microscopically, the precipitate is an amorphous sediment. True phosphaturia—that is, an actual increase in the amount of phosphoric acid eliminated in the urine in twenty-four hours—is a very rare disease which comparatively few observers have ever seen.

Triple Phosphates.—Triple phosphates or ammonio-magnesium phosphates are products of decomposition, and appear when fermentation sets in, never in fresh urines. They are easily recognized by the characteristic crystalline form. The crystals are coffin-shaped and very characteristic (Fig. 6). When seen at all, they are usually in large numbers. They are chiefly of importance when decomposition takes place in the bladder in consequence of diseased conditions of the bladder or prostate, as they are then often deposited in large quantities and quickly form calculi. These calculi are frequently found in men leading catheter lives who are not over-cleanly in the care of their catheters.

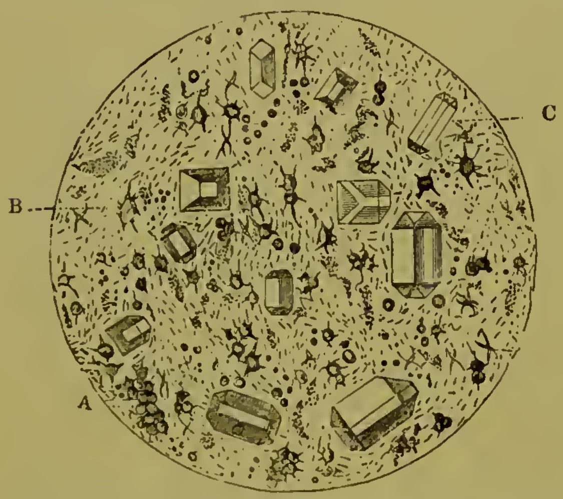

Fig. 6.—Deposits in ammoniacal urine (alkaline fermentation): *A*, acid ammonium urate; *B*, ammonio-magnesium phosphate; *C*, bacterium ureæ.

Albumin.—A generation ago it was the medical belief of the day that albuminuria was a dangerous symptom, generally indicating organic disease of the kidney of a serious nature and warranting the gravest prognosis. To-day we know it to be true that albuminuria is not necessarily a symptom of gravity, and that it often exists, especially in persons beyond middle life, with no other indication of renal disease than, perhaps, a few hyaline or fine granular casts—so few as to be often hard to find.

In fact, so much has been written on this subject of late that the present-day observer is, perhaps, going to the other extreme and manufacturing evidence to show that albuminuria has often no clinical significance and need cause no apprehension in the mind of the physician. Whether or not there be a physiological albuminuria, it is not in the province of this treatise to discuss. The line between health and disease is not an easy one to find, and the term "physiological" might prove hard to define in this connection. At all events, albumin in the urine, if it means nothing else, means that the utmost watchfulness and care should be used before deciding that it has no clinical significance.

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[1] See the writer's paper on "Phosphaturia," *Boston Med. and Surg. Journ.*, Feb. 8, 1894.

In testing the urine for the presence of albumin we are fortunate in having two tests, the heat and nitric-acid tests, which are most satisfactory as being amply delicate enough for clinical purposes, easily carried out, and sustained by the proof of long and satisfactory trial. In the hands of the writer the heat test is perhaps a little the more delicate, but the difference is slight, and either is capable of demonstrating one-twelfth of 1 per cent. by weight of albumin. It may, as a rule, be taken for granted that these two tests are capable of demonstrating any amount of albumin that has clinical significance, and it is the writer's practice to use no other tests than these two.

To carry out the heat test, fill a test-tube about half full of urine which has been previously filtered if it contained any pus; add two or three drops of acetic acid, and then in a flame heat the upper part of the fluid to the boiling-point. The acetic acid will have eliminated any phosphatic cloud which was present, and the heat will have carried away any cloud of urates before the precipitate of albumin begins to appear as a white cloud in the heated portion of the column of urine. If the amount of albumin is very small, the cloudiness may be quite difficult to see, and a dark-covered book will often do good service as a background to make more marked the contrast between the clear fluid below and the turbid area above. If the amount of albumin is greater, the cloudiness is more flocculent, and if the amount is large, the precipitate may solidify in the test-tube and not pour out when the tube is inverted.

The nitric-acid is the most commonly used of all the tests, and is easily carried out. Fill a cup-shaped (not conical) sherry-glass from one-third to one-half full of urine. Tilt the glass to moisten the sides of it up to the rim, and then pour gently and slowly a dram or so of pure nitric acid down the tilted side of the glass, so that it may trickle gently down into the urine and sink to the bottom of the glass, which it will do at once if the test is properly executed. The line where the two fluids join is well marked, and there, if albumin is present, it appears as a sharply-defined white zone, varying in thickness and density according to the amount of albumin, but always situated at this point and always sharply defined.

Various conditions obscure this test. The turbidity due to phosphates is readily dispelled by a drop or two of acetic acid; that due to urates, by a little heat: if pus is present, it can usually be filtered out with ease before the test is applied, but if there is much blood present, there is no need of going through the test at all, for albumin from the blood-serum must necessarily be present in such conditions even if the urine be filtered. Decomposed urines are difficult to test in this way, as the turbidity obscures the test and the effervescence caused by adding acid to an alkaline urine interferes with the delicacy of the test. In such urines the test for albumin is of little value. Again, if the specimen to be tested is rich in urates, we often get, on the addition of the acid, a zone of urates which may easily be confused with one of albumin. The urate zone always occurs in the urine and not at the union of the urine and acid; so it is higher up and has a layer of urine beneath as well as above it. Very rarely the nitric acid precipitates a layer of a substance (thought to be mucin) which may cause confusion. The upper surface of this zone is not sharply defined, and it tends to spread quickly and cloud the whole urine. It is very rare and hardly needs mention.

If a more delicate test for albumin is desired, the method of Millard may be used. The fluid consists of—acid. carbolic., 20 c.c.; acid. acetic., 70 c.c.; liquor potass., 220 c.c. To about a dram of this fluid add, drop by drop, the urine in question, letting it trickle slowly down the edge of the glass containing the reaction fluid. The presence of albumin is indicated by a fine white deposit at the point of union of the two fluids.

The nitric-acid test for albumin is of the greatest importance, for by it not only can we demonstrate the presence of albumin, but we can, if experienced, tell its quantity at a glance with extraordinary accuracy—in fact, with a degree of accuracy such that for the physician experienced with this test no further quantitative estimation or test for albumin is necessary for clinical purposes. The greatest care is necessary in adding the nitric acid to the urine, so that the spreading of the zone from the agitation of the fluids shall be minimized. Without this precaution the zone of albumin will appear heavier than it should, and so lead one to an over-estimation of its amount. If the zone be examined as soon as formed and the above precautions be carefully followed, it may be stated as a rule that the faintest possible trace of a zone represents one-twelfth of 1 per cent. by weight of albumin. From this up to 1 per cent. the amounts can be calculated by the experience of the observer. Any zone of less than 1 per cent. can be looked through from above downward, so that the bottom of the glass can be seen. If 1 per cent. or more is present, the zone is opaque. When the amount is very great the zone takes on a peculiar thick, curdy appearance which is characteristic of at least 2 per cent. of albumin. Larger amounts than 2 per cent. are very rare, but when present even the experienced eye cannot estimate them by this test. The only great objection to this method of quantitative estimation of albumin is that it takes for granted a considerable experience. This experience must be great, because absolute accuracy and uniformity of observation are the necessary ends to be reached.

Whatever may be one's belief as to the possible indications of albuminuria which is physiological and of no clinical importance, it must be admitted that the constant presence of albumin in the urine is suggestive, to say the least, of disease; and it is the writer's belief that a little time and care will usually suffice to demonstrate the cause of its presence. For example, in the cases in which albumin is present after violent exercise, and not at times of rest and quiet, it is common that the urine contains a little sandy material after exercise, quite enough to be the irritating cause which suffices to produce the albumin, but still so small an amount as to be easily overlooked.

Small portions of albumin are usually referable to the kidneys if pus and blood can be ruled out as a reason for its presence. Occasionally disease of the seminal vesicles or prostate may explain its presence as a symptom. In the latter case the microscope will reveal seminal or prostatic secretion in the urine. Similar slight albuminurias are sometimes the product of the action of certain drugs which irritate the kidneys, such as turpentine, cantharides, and salicylate of soda.

In diseases accompanied by obstruction of the cardiac or pulmonary vessels, also in conditions where there is a mechanical obstruction to the circulation produced by a tumor, the pregnant uterus, etc., albuminuria is a common occurrence. Again, in acute febrile conditions, such as the eruptive fevers, typhus fever, and septicemia, we get albuminuria due to the accompanying renal condition. Finally, we have to consider the albuminurias due to organic disease of the kidneys themselves.

When a urine contains blood, it need never be tested for albumin, as, no matter how carefully it be filtered, albumin from the blood-serum will still be present. In such cases albumin may, of course, be taken for granted and the test be considered of no significance. Albuminuria from purulent urine needs consideration. Pus in any amount invariably means albumin. Generally it is found in filtered specimens in comparatively small amounts (in the neighborhood of $\frac{1}{6}$ per cent.), whether the pus comes from a gonorrhea or vesical condition due to whatever cause—*e. g.* the extension backward of a gonorrhea, obstructive diseases of the prostate, stone, and the earlier stages of a tubercular process.

In cases where the amount is much larger than this (*i. e.* about 1 per cent.) pyelitis should be looked for carefully, unless there be an ulcerated bladder or a condition (prostatic or otherwise) associated with great tenesmus; for both of these last two conditions are often associated with urines containing large quantities of albumin, and it is surprising to see how quickly the relief of the condition by operation will cause a marked diminution in the amount of albumin in the urine.

True renal albuminuria remains for our consideration. The amount of albumin present is always important, as it is sometimes a symptom of diagnostic significance. Of the renal conditions that are accompanied by large amounts of albumin may be mentioned, first, the early stages of acute nephritis, where the amount is often over 1 per cent., although in conditions of active renal hyperemia we may get but a trace of albumin; second, the earlier and more active stage of a chronic parenchymatous nephritis, where the amount is sometimes so large as to solidify in the test-tube when the heat test is applied (over 2 per cent.); third, the later and more inactive stage of chronic parenchymatous nephritis, where the amount, although much decreased, is still apt to remain in the neighborhood of $\frac{1}{2}$ per cent.; fourth, in the later stages of amyloid kidney. In the first stages of tubercular and chronic interstitial kidney, in gouty kidney, and in amyloid kidney (except in its last stage) there is usually a fairly large amount of albumin in the urine, generally in the neighborhood of $\frac{1}{4}$ per cent., although at the stage of the disease when chronic interstitial nephritis (contracted kidney) is most often recognized clinically the amount is much smaller than this, and may be so small as to be incapable of demonstration by either the heat or the nitric-acid test.

The amount of urine is usually very large in such conditions. Millard's test, which is much more delicate than the others, rarely fails to demonstrate the presence of albumin. There are always exacerbations which are readily recognized if these cases are watched for any length of time. At these periods the microscope will show a sediment about which there can be no doubt. The albumin will be present in much larger quantities, and sometimes, though not often, there is present as much as $\frac{1}{4}$ per cent.

In cases of dilated bladder from an obstructing prostate, where the obstruction has existed for a good while, and also in cases of hydronephrosis, the amount of albumin in the urine is usually small as long as the pressure of the fluid exists. If that pressure be suddenly relieved by catheterization or otherwise, there is usually a marked inflammatory reaction and a much greater quantity of albumin in the urine. Such cases often assume the most serious aspect.

To classify rudely these different conditions, then, we may say that we have considered—1. Idiopathic or physiological albuminurias, which are usually slight, intermittent, and are rarely of long duration or of much clinical importance; 2. The cases due to conditions outside the kidneys—*e. g.* albuminurias in acute fevers, from drugs, obstructive tumors, in old people with atheromatous vessels, and in conditions associated with pus or blood, or both, in the urine; 3. True renal albuminurias, due to organic disease of the kidneys themselves. Great care should be taken not to let class 1 get too large by the addition to it of many cases where a little patience will suffice to demonstrate a more or less obscure cause for the albuminuria.

Sugar.—Of the etiology of diabetes we know but little. It is a constitutional rather than a local disease, which Osler, in his *Text-book of Medicine,* defines as "a disorder of nutrition, in which sugar accumulates in the blood and is excreted in the urine, the daily amount of which is greatly increased."

Glycosuria, then, is merely the manifestation of this general condition, and the sugar in the urine is not due to any disease of the renal structures, which may be in good condition and doing their work perfectly well, although in some cases of persistent glycosuria we find a trace of albumin caused, perhaps, by the passage of the sugar through the kidneys. Of the common causes of glycosuria, heredity should perhaps head the list. Many conditions of the nervous system seem to have a causative influence, and especially conditions involving injury of the brain or spinal cord.[1] Obesity and dietetic excesses are occasionally associated with temporary glycosuria, especially if excessive amounts of saccharine food be ingested. In the real diabetic, however, sugar is practically never absent from the urine, and it is only by the most careful dietetic and hygienic care that its accumulation in the blood, and so in the urine, can be held in check. The disorder is not well marked clinically, and were it not for urine-analysis many cases would inevitably escape detection. Its tests are therefore important, and especially so its quantitative estimation, for by this means alone are we able to watch the progress of the disease and the effect of our efforts against it with any degree of accuracy. Again, too, the ordinary tests for sugar are apt to mislead as to even the approximate amount present in the urine, for the same patient will often pass a very large quantity (in twenty-four hours) of a urine of a low (for diabetes) specific gravity, each specimen tested containing but little sugar, while on the next day the amount passed for the twenty-four hours will be comparatively small, but of a high specific gravity, each specimen tested containing a large amount of sugar. Yet the total amount of sugar excreted in the urine in twenty-four hours may be the same for these two days. So it is evident how carefully the amount of urine, as well as the amount of sugar contained in it, should be watched in the progress of diabetic conditions.

Of the many useful tests for the presence of sugar in urine, the two which seem best adapted for general use are the Fehling's-solution test and the fermentation test. Fehling's solution is a solution of copper sulphate and an alkaline tartrate (sodium). As this makes a combination which does not keep, the copper and tartrate solutions should be kept in separate bottles. To make the test, add to equal quantities of the copper sulphate and tartrate solutions, which have been mixed in a test-tube, about a dram of water; boil for a few minutes to make sure that the solution remains clear, and is therefore fit for use; add the urine drop by drop until about the same quantity has been added as was used of each of the other two substances.

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[1] See "Traumatic Glycosuria," by Higgins and Ogden, *Boston Med. and Surg. Journ.,* Feb. 28, 1895.

If sugar is present, there results a yellow-red precipitate which is so easily seen and so characteristic that it cannot be mistaken. This is an admirable test, quite accurate enough, and having the sole drawback that the solution does not keep well. If the two ingredients be kept in separate bottles properly corked, and the above safeguard be adopted, but little trouble will be experienced.

Dr. Fuller of New York describes a modification of this test which was recommended to him by Dr. Keyes, which he uses because it is easy to carry out and does not involve the employment of the unstable Fehling's solution. It may be done as follows: To 1 dram of liquor potass. in a test-tube add 3 or 4 grains (approximately) of tartaric acid; heat to boiling; then add 6 to 10 drops of a solution of 40 grains of copper sulphate in an ounce of pure glycerin; shake and heat again. To this fluid, which is of a deep-blue color, add the urine to be examined, a few drops at a time, heating between each series of drops, until you have added about half as much urine as there was of the solution in the tube. You get the characteristic yellow precipitate quickly or slowly according as there is a larger or smaller amount of sugar present in the urine.

The fermentation test for the presence of sugar in urine depends upon the fact that grape-sugar and yeast decompose to make alcohol and carbonic-acid gas. It may be easily done, and with a fair degree of accuracy, in the following simple way:

Take two four-ounce bottles of the urine to be tested. In bottle No. 1 put a little yeast; leave it unstoppered and put it in a warm place for twenty-four hours. Put bottle No. 2 in a cool place without any yeast, and at the end of twenty-four hours bring the second bottle to the same temperature, and take the specific gravity of the two specimens of urine. Specimen No. 1 will have a specific gravity much lower than specimen No. 2, and it may be considered as approximately true that each degree of specific gravity lost by fermentation represents 1 grain of sugar to the fluid-ounce of urine. To calculate the percentage of sugar present, multiply the number of degrees difference in the specific gravities of the two specimens by the fraction $\frac{23}{100}$.

Dr. Max Einhorn of New York has invented a saccharometer (Fig. 7) that makes this fermentation test as easily carried out and much more accurate than the above approximate method. The apparatus is accompanied by a set of directions for its use, which the writer appends:

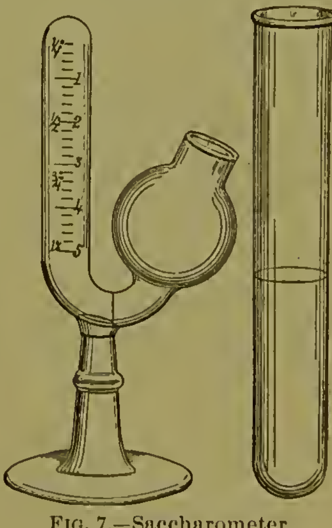

FIG. 7.—Saccharometer

"Directions: Take one-sixteenth of a cake of Fleischmann's yeast (wet compressed cakes), and shake thoroughly in the graduated test-tube with 10 cubic centimeters of the urine to be examined. Then pour the mixture into the bulb of the saccharometer. By inclining the apparatus the mixture will easily flow into the cylinder, thereby forcing out the air. Owing to the atmospheric pressure the fluid does not flow back, but remains there.

"The apparatus is to be left undisturbed for twenty to twenty-four hours in a room of ordinary temperature.

"If the urine contains sugar, the alcoholic fermentation begins in about twenty to thirty minutes. The evolved carbonic-acid gas gathers at the top of the cylinder, forcing the fluid back into the bulb.

"On the following day the upper part of the cylinder is filled with carbonic-acid gas. The changed level of the fluid in the cylinder shows that the reaction has taken place, and indicates by the numbers to which it corresponds the approximate quantity of sugar present."

If the urine contains more than 1 per cent. of sugar, it must be diluted with water before being tested.

Diabetic urines of straw-color and a specific gravity of 1018–1022 may be diluted twice; those of 1022–1028, five times; those of 1028–1038, ten times. The original non-diluted urine contains, in proportion to the dilution, two, five, or ten times more sugar than the diluted urine.

The quantitative test for sugar with Fehling's solution requires very carefully prepared solutions; that with the polariscope, an expensive instrument; so that for all ordinary purposes the fermentation test may be conveniently used, the method with the two bottles giving only approximate results, while that of Dr. Einhorn's saccharometer gives fairly accurate ones.

SEDIMENTS.

The crystalline structures which are commonly seen in the sediment of urines have been briefly considered under the several headings of the constituents which compose them. It remains for us to make brief mention of the organized sediments which are most commonly met with in pathological urines.

The study of sediments depends almost entirely on the microscope, and therefore what can be written on the subject in a brief way can be of little service in comparison with the knowledge which careful observation gives. It is the writer's purpose to make this portion of the treatise so brief as to be almost schematic, realizing that it can be at best a very slight aid to a knowledge of urinary microscopy, which nothing but accurate observation and experience can give.

Epithelia.—Epithelium plays a very important part in urinary diagnosis, for by its aid we are often able to locate a pathological process with absolute accuracy, and in many cases where this is not possible valuable suggestions will come from cells which are less accurately characteristic.

Epithelial cells in the urinary tract vary greatly in shape, size, and structure. This is true not only in different parts of the tract, but in different layers of the same piece of membrane. It may be stated as a rule that the cells are coarsest and least delicate in the anterior urethra, and become finer in structure (not in size) as they progress toward the kidney.

The same is true, but to a less marked extent, of the cells of the different layers of the same locality, the new cells of the deeper layers being the most delicate, while those of the older and outer layers are the least so. It is also true that, leaving out the male urethra and beginning in the bladder, the cells progressively diminish in size the higher up toward the kidney one goes.

Epithelial cells from the renal tubules are round in shape and about the size of pus-corpuscles, those from the smaller tubules being a little smaller and those from the pyramids a little larger than this. These cells may be distinguished from pus-cells by their nuclei, which are usually very large.

Cells from the pelvis of the kidney are battledore-shaped, although a few such cells come from the tubules at times. A long-continued pyelitis puts round-cells from the deeper layers in the urine, and few or none of the others can be seen. These round-cells from the pelvis of the kidney cannot be distinguished from those coming from the small renal tubules. Usually, however, the amount of blood and pus present or crystalline elements from a calculus will make the distinction. These cells are also readily confounded with those from the deep layers of the vesical membrane. The latter are, however, rather larger in size and of firmer structure (Fig. 8).

Cells from the ureters are spindle-shaped, and are very rarely seen in urine, as the ordinary forms of inflammation in the urinary tract usually skip the ureters in their course. The ureter-cells are seen only after the passage of a calculus from the kidney to the bladder or during the inflammatory process that results from such a passage.

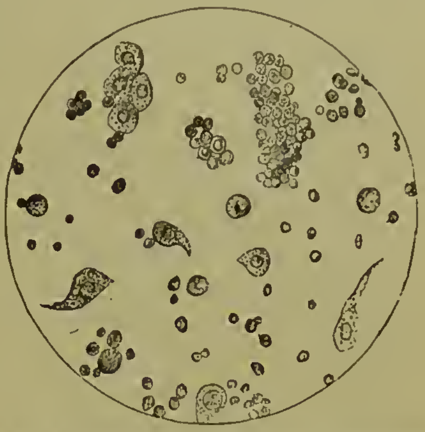

FIG. 8.—Renal epithelial cells and epithelial cells from renal pelvis.

Bladder-cells are polygonal plates much larger than any of the cells just mentioned, being usually about double the diameter of the renal or pelvic cell. We cannot tell from a single cell whether it is from the bladder or vagina, but the grouping always solves this difficulty; cells from the bladder being seen usually in a single layer, while vaginal cells occur in layers overlapping each other, and they occur in large numbers not associated with the pus which would be the invariable companion of a similar number of vesical cells. Cells from the deeper layers of the vesical membrane appear in the urine in inflammations of a very severe type. They are always associated with a great deal of pus, and are round or oval in shape, resembling cells from the neck of the bladder, although of rather more delicate structure than the latter.

Cells from the neck of the bladder, from the female urethra, and from the prostatic urethra cannot be accurately distinguished. They are denser in structure than ordinary bladder-cells, and are round or oval in shape. Those from the male urethra are found progressively smaller in size as they go down the urethra, and are best seen in the shreds found in the last stages of urethritis. These shreds are composed of pus, a little blood, and a number of round or oval and occasionally caudate cells caught together in a mucous vehicle (Fig. 9). The prostatic cells are often found in pathological conditions where they are associated with prostatic fluid, and can sometimes be localized by this means.

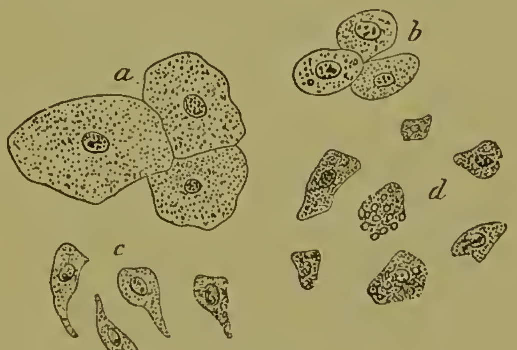

FIG. 9.—Epithelium from the urine: *a*, *b*, epithelium from the bladder, from the pelvis of the kidney; *c*, caudate epithelium (pelvis of the kidney?); *d*, renal epithelium partly changed into fat (Vierordt).

Cells from the anterior urethra are of little diagnostic importance, as the discharge at the meatus, together with the endoscope, serves much better for diagnostic purposes.

It is evident that the cell-characteristics of one area of membrane very often merge so gradually into those of the neighboring regions that accurate lines of demarcation are impossible. None but the experienced observer can give even an approximate idea of location in many instances, even with the aid of other more or less characteristic evidences in the sediment.

Pus.—Pus is so common a constituent of urinary sediments that its careful study is of the utmost importance, for its very prevalence is apt to make the observer careless and to belittle the part it plays in urinary diagnosis. Pus-corpuscles are about the size of renal epithelium, but have a very distinct outline, and usually more than one nucleus, the most common number being three. The corpuscles have a granular appearance, and if the inflammation has lasted for some time, they lose their distinct outline and their nuclei become less distinct and often take on a horseshoe shape, which is more or less characteristic of old pus.

Pus means inflammation, and where pus is present in the urine its presence means inflammation somewhere in the urinary tract or, more rarely, in some pocket or sinus opening into it. Pus in any quantity is readily seen; in moderate amounts it merely clouds the urine, while in greater quantity it makes it thick and viscid as well as turbid.

The turbidity due to pus may readily be mistaken for that due—1, to bacteria; 2, to phosphates; 3, to urates. The two last-named forms, as we know, are readily distinguished from pus-turbidity by chemical means, and the first-named by the microscope, although the presence of bacteria presupposes a greater or less amount of pus as its companion in the urine.

There are, however, certain bacterially infected urines in which the acuteness of the inflammatory process has long since subsided, the quantity of pus has much diminished, and yet the number of bacteria remains very large. These urines often have but little sediment, and are clouded after long standing, the turbidity showing no tendency to diminish by the settling of the sediment to the bottom of the glass. More commonly, however, pus is present in quantities sufficiently large to pretty well conceal bacterial evidence until it is demonstrated by the microscope.

Before going on to a somewhat detailed consideration of the microscopic appearance, methods of localization, and the diagnostic value of pus in the urine, there are two pus-containing urines so characteristic and so easily contrasted in gross appearance that they should receive separate mention. First, there is a urine which is turbid with pus, but is properly acid, and of low rather than high specific gravity. The pus settles promptly into a small solid mass at the bottom of the glass, leaving above it a clear, good-looking urine. In the absence of a urethral inflammation of sufficient intensity to account for this pus, a pyelitis may be inferred. The urine will keep its acidity, while the pus will remain with few if any degenerative changes for some days.

In direct contrast with this is another class of pus-containing urines in which the acidity is quickly lost and the turbidity remains often after some hours' standing. When the sediment settles, it does so in a half-hearted way, appearing as a loose, flaky layer with uneven surfaces. If the settling has been very slow and the acidity therefore has gone, the sediment appears as a thick, gummy mass which does not redistribute itself uniformly through the urine if the vessel is shaken. Such urines indicate a cystitis.

Briefly, then, renal and pelvic pus settles quickly, and urines containing such pus retain their acidity, while bladder-pus settles badly and the urine decomposes quickly.

Having demonstrated pus in a urine, it remains to localize its source as accurately as possible, and then to consider its significance in the diagnosis and treatment of the case. This localization must be done, if at all, by a knowledge outside that furnished by the pus itself, for, except for the degenerative changes just mentioned, all pus looks alike under the microscope. If the pus comes from the kidney, we are apt to have an acid urine with a sediment of pus, perhaps a little blood, and casts which may have pus-cells adherent to them. If the inflammation is a pyelitis, the urine is acid and the pus is not in clumps, while instead of casts we find many caudate or round epithelial cells according as the case is acute or of a more chronic type. If the bladder is the part involved, there is usually abundant epithelial evidence to show it and the diagnosis is easy.

There are, however, as will be seen presently, cases in which much difficulty may be experienced in localizing the inflammation. Pus from the urethra, excepting the prostatic portion, is rarely difficult to locate; if from the anterior portion, it appears or can be made to appear as a discharge more or less constant, and the second urine (if the micturition be divided between two glasses) will be clouded, all the inflammatory products being washed away in the first part of the stream. If the discharge is very small in amount, the endoscope may be necessary for the diagnosis.

Pus from the prostatic urethra is sometimes difficult to locate in chronic conditions. If the process is acute and the pus abundant, it flows back into the bladder and clouds the second portion of a divided urine, so that the two specimens look alike. Given, then, a urine turbid with pus, how shall we go to work to find its source? Have the patient pass the urine in two portions as nearly equal in amount as possible. If the second portion is clear, the discharge comes from the anterior urethra. If both are clouded, we have to consider, first, the prostatic urethra; second, the bladder; third, the pelvis of the kidney and the kidney. The ureter, as has been said, is rarely involved in the inflammation.

1. The deep urethra can usually be excluded as the seat of inflammation if the finger in the rectum or a steel sound in the urethra gives no marked tenderness and no blood follows such an examination.

There are, however, chronic cases of such inflammation where the discharge is so slight as not to flow back into the bladder and cloud the second urine, but is washed out in the form of shreds in the first portion of the urine. In these cases, although the diagnosis is often difficult, the microscope usually suffices to make it by demonstrating prostatic fluid and epithelial evidence of prostatic trouble. Of course the clinical history is often of the greatest assistance.

2 and 3. The bladder can be investigated by the cystoscope, and so the diagnosis is easy, but if this instrument is not at hand or its use is for any reason contraindicated, the investigation can be fairly well continued by washing out the bladder very carefully and thoroughly until the washed fluid comes away perfectly clean. Then have the patient urinate at the end of an hour or so, and compare the voided urine with that passed before the washing. If the urine passed before the washing is no more turbid than that after the thorough bladder-cleaning, it is probable that the pus comes from the kidney and not from the bladder. For if the latter organ was diseased, the pus ought not to accumulate in an hour to such an extent as to make the turbidity as marked as it was before. If the pus comes from the kidney, pain, tenderness, and possibly tumor often point to one side rather than the other, and the cystoscope, by bringing the mouths of the ureters into view, will sometimes make the diagnosis. Occasionally, on examining the second portion of urine, we find that it is more clouded than the first part, and sometimes that the greatest cloudiness appears in the very last part voided. This means (*a*) that there is an acutely inflamed prostate whose muscular contractions at the

end of micturition are most energetic and are squeezing out a large amount of inflammatory discharge; (*b*) that the case is one of pyelitis in an old person, or (*c*) of chronic prostatic hypertrophy with an atonic condition of the bladder, which allows the pus in the urine to settle at the bottom of the bladder, and so the settlings pass off in the greatest amount in the last part of the urine voided or drawn. The first of these conditions is associated with the pain and tenesmus of an acute inflammation; the latter two are not.

Pus coming from the kidney usually means—1. Extension of a gonorrhea; 2. The results of prostatic obstruction; 3. Calculus; 4. Tubercle; 5. Bacterial invasion of the urinary tract; 6. Abscess from a constitutional cause; 7. Traumatism; 8. New growth.

Pus coming from the ureter usually means the passage of a calculus or its resulting inflammation.

Pus coming from the bladder usually means—1. Gonorrhea and stricture; 2. Obstruction from prostatic disease; 3. Traumatism from stone, instrumentation, or from without; 4. Tubercle; 5. Bacteria; 6. New growth.

Pus coming from the prostatic region usually means—1. Gonorrhea; 2. Prostatic hypertrophy; 3. Tubercle; 4. Traumatism from stone or from without; 5. New growth.

Pus coming from the seminal vesicle usually means—1. Gonorrhea; 2. Tubercle; 3. Sexual excesses; 4. New growth, usually secondary.

Pus coming from the urethra means urethritis due to—1. Gonococcus; 2. Traumatism; 3. Tubercle; 4. Chancroid; 5. Syphilitic ulceration; 6. Malignant disease.

Blood.—In considering the subject of blood in the urine the writer will confine himself to hematuria as distinct from hemoglobinuria, the latter being a rare condition which has already been referred to in this treatise.

Blood appearing in the urine in amounts large enough to alter its gross appearance has been mentioned in speaking of the color of the urine. The red blood-corpuscles seen microscopically in the sediment of the urine appear very much as do normal blood-corpuscles elsewhere, except that they do not appear in rows and that they have lost their mobility.

They are seen as round disks with a little yellowish tinge of color and a rather high refractive power. The longer they are present in a diluted urine the less easy they are to recognize, as they lose their color and refraction, their biconcavity gradually disappears, and they become globular and full of water.

If the urine is concentrated, on the other hand, they often assume an irregular shape and a shrivelled and dried-up appearance. Blood in the urine may have its origin in any part of the urinary tract, and, of course, the localization of the source of hemorrhage is of the greatest clinical importance. The writers on this subject are fond of making the statement that the only question of real difficulty is the differentiation between renal and bladder hemorrhage, as urethral hemorrhage is rarely difficult of diagnosis, and ureteral hemorrhages and those from the seminal vesicles are extremely rare.

Such statements are in the main true, and yet hemorrhage from the urethra, and especially from the prostatic portion, is common enough to merit always a most careful consideration. The appearance of blood at the meatus, together with a history of urethral inflammation, past or present, and the absence of symptoms pointing to the bladder or kidney, will usually make a diagnosis of urethral hemorrhage which the endoscope will corroborate, "but it is not sufficient to say that the urethrorrhagia, whether from a traumatism or otherwise, is diagnostic of itself, for the writer has seen a sequel of gonorrhea in the urethra permit blood to exude which escaped only with urination; nor is it enough to say that blood from the urethra will find its way out in the intervals of urination and has no relation to the act. Blood can escape from this canal during the act of urination. The physiological action of the urethra may cause blood to escape from a diseased area sufficient in quantity to be commingled with the urine as the latter passes, and there be no appearance of it at any other time."[1]

Hemorrhage from the deep urethra is usually slight in amount, and has for its companion, as a rule, an amount of inflammation giving rise to pretty severe spasm of the muscles of expulsion; so it is common in such cases to have most of the blood appearing at the very end of micturition, the increased spasm at the end of the act irritating the inflamed surfaces of the membrane much more than at the beginning of the act.

In these cases there will usually be a few drops of clotted blood at the meatus at the end of micturition, and at the succeeding act of urination the clots of blood which have been lying in the canal since the last effort will be washed out in the urine. If the bleeding from the deep urethra is unaccompanied by any spasm and is large in amount, as it usually is under such circumstances, it flows back into the bladder and may even fill that organ. This may occur with the hemorrhage which often accompanies cases of chronic prostatic hypertrophy.

Ureteral hemorrhage occurs only as a result of the traumatism caused by the passage of a stone from the kidneys to the bladder. Here the clinical history and symptoms will make the diagnosis quite apart from any signs of blood in the urine.

Hemorrhage from the seminal vesicles is a result of an inflammation, usually due to gonorrheal infection. It is probably caused by the muscular contraction of the organs in expelling their contents at the time of ejaculation. The hemorrhage is evidenced by bloody seminal discharges, and is usually very slight in amount.

In discriminating between renal and vesical hemorrhage there are often many points in the clinical history of the case which will be of the greatest aid to the surgeon in his efforts at localization, but it is not possible to take up the question from this point of view in a short sketch like the present one. It is often written that blood coming from the kidney is blackish or brown in color, while that from the bladder is of a brighter red color.

The writer has never been able to verify this statement, for, although it is true, as a rule, that renal bleeding is less abundant and less persistent than bleeding from the bladder, the color alone is not necessarily an indication or even a suggestion of the source of the hemorrhage; and we may have a diseased bladder voiding a blackish urine in which the blood is very thoroughly mixed, while, on the other hand, we may have a hemorrhage from the kidney containing bright-red blood.

As a rule, the vesical bleeding is more abundant and more likely to coagulate in the bladder. So, if in attempting to use a cystoscope (which is, of course, of the greatest assistance in many of the cases, especially the renal ones) we find that in our preliminary washings it is comparatively easy to get the bladder washed out clean and to get a good view of the vesical interior, that is distinctly a suggestion that the hemorrhage is from the kidney. When the source of the bleeding is vesical, it is frequently difficult, and often impossible, to get the bladder clean enough to render the use of the cystoscope possible. In renal cases where the cystoscope is successfully used it is easy to see the blood as it enters the bladder from one or the other ureter.

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[1] L. B. Bangs: "Blood in the Urine," *Medical Record*, Nov. 5, 1892.

In these cases there sometimes form blood-casts of the ureter on the affected side, and such casts, washed into the bladder and voided at a subsequent urination, are often important diagnostic points in favor of a renal, or more commonly pelvic, source of the hemorrhage.

Of the iodide-of-potash test, advocated and described by Dr. W. K. Otis of New York, the writer cannot speak from experience. To make this test, the bladder to be examined is filled with a solution of iodide of potash, and then, after a short time has elapsed, the patient's saliva is tested for iodide of potash. If present, the hemorrhage is vesical. If absent, the bladder is healthy, as it is held that if the vesical membrane is whole and uninjured no absorption takes place.

Hemorrhage to any extent rarely takes place from the kidney without giving rise to colicky pains on the affected side, and on palpation we find tenderness and possibly tumor, locating the hemorrhage in the kidney of that side. Bladder-hemorrhage, on the contrary, may take place in the absence of inflammatory conditions and with no symptoms pointing to it. It is by no means uncommon for genito-urinary surgeons to be consulted by patients with hematuria who had no inkling of any trouble until they saw the blood in the urine.

Renal hemorrhage is, of course, increased by the instrumentation, irrigations, etc. which a proper examination renders necessary, while vesical hemorrhage is often much increased in this way. Surgeons are constantly reporting cases of renal hemorrhage of obscure origin often cured by an operation which in no way explained the cause of the bleeding.

The above comprise a few of the most important points in connection with the clinical aspects of hematuria. It is to be deplored that a more complete consideration of this most interesting subject is beyond the possibilities of this treatise, as is also anything like a detailed enumeration of the many pathological conditions of which hematuria is often a symptom of prominence.

Hemorrhage from the kidney usually suggests—1. Acute nephritis; 2. Calculus; 3. New growths; 4. Tubercle; 5. Traumatism; 6. Syphilis (rare); 7. Echinococcus (rare).

Hemorrhage from the ureter usually suggests the passage of a calculus.

Hemorrhage from the bladder usually suggests—1. New growth; 2. Calculus; 3. Tubercle; 4. Traumatism; 5. The sudden emptying of an atonied bladder behind an enlarged prostate; 6. Gonorrheal ulceration (rare); 7. Syphilis (rare).

Hemorrhage from the seminal vesicles usually suggests—1. Gonorrheal inflammation; 2. Tubercle; 3. Malignant disease, usually secondary.

Hemorrhage from the deep urethra usually suggests—1. Gonorrheal inflammation; 2. Inflammation behind a stricture; 3. Traumatism from calculus or from without; 4. Tubercle; 5. New growth; 6. Chronic prostatic hypertrophy.

Hemorrhage from the anterior urethra usually suggests—injury from outside causes, such as instrumentation; injuries during intercourse; kicks; irritating injections; the breaking of a chordee by force, more rarely a foreign body; a tubercular, syphilitic, or chancroidal ulceration; or a localized patch of diseased membrane following an old gonorrhea.

Carcinoma of the penis of course may cause hemorrhage at the meatus.

• **Casts.**—The inflammatory material which exudes from the walls of the secreting tubes of the kidney under certain conditions often appears in the urine as a moulded form of the lumen of the tube from which it came. This form is called a cast. Occasionally similar casts are formed in the prostate, but they come usually from the kidney, and their presence in the urine invariably means trouble of some sort in that organ, although the trouble may not have lasted long enough or have been severe enough to be dignified by the name organic disease.

The material that is the basis-substance of all casts is a hyaline material, soft, translucent, and pliable to a degree, although adhesive enough to retain its original form during its passage through the urinary tract. This hyaline substance is colorless, and is sometimes so transparent that it is difficult to see it in the field of the microscope. On the other hand, it may be so firmly pressed and moulded as to lose its transparent look and assume a waxy appearance. It is often discolored, and assumes various appearances from admixture with other substances, such as blood-pigment or granular detritus. It often has cellular and other elements adherent to it, so casts are named according to the appearance they present. The usual forms are designated as follows: pure hyaline; finely or coarsely granular—that is, casts made of a mixture of hyaline material and finely or coarsely granular detritus; brown granular—that is, granular casts stained with blood-pigment; waxy—that is, dense, waxy hyaline casts; epithelial—that is, the cast has adherent epithelium; blood—that is, casts with adherent blood-corpuscles; fatty—that is, casts with adherent fat-globules; fibrinous—that is, a hyaline, non-granular cast stained with pigment.

Casts are the size of the caliber of the tube from which they come, so that those from a child's kidney are smaller than those from the same part of an adult kidney, and those from the straight tubes are larger than those from the convoluted tubes. They are cylinder-shaped, and are often characteristic enough in appearance to be recognized by observers of very slight experience.

On the other hand, these casts may often be mistaken for other things—*e. g.* a bit of mucus rolled upon itself. If the outlines of the object which is being examined under the microscope be focused very carefully, its well-defined parallel sides and its distinctly rounded ends will usually mark it as a cast, while if it is mucus its uneven appearance, the lack of parallelism in its sides, and its indefinite fimbriated ends are usually manifest.

Casts are said to be formed in the prostate at times. This variety cannot be distinguished from renal casts, except that renal casts are usually seen isolated in the urine and not in groups or mixed with other material, while sometimes casts are seen mixed up in a mass of prostatic fluid in a urine containing little or no albumin. These are possibly casts from the prostatic tubules occurring in cases of inflamed and hypertrophied prostates. The writer has never been able to convince himself that such casts do exist.

The significance of casts in the urine cannot here be considered at any length. The mere presence of casts of any sort means, perhaps, only a temporary congestion of the organ or a more definite hyperemia. It may, but does not of necessity, mean organic disease of the kidney. The kind of casts—*i. e.* their shape, size, and appearance—is often an aid in diagnosis, certain forms being more or less definitely associated with certain varieties of renal disease.

Hyaline casts (Figs. 10, 11) occur so commonly as to be the least distinctive of all. They are generally present in passive congestion of the kidneys, during the period of recovery from an acute nephritis, and very generally in a variety of chronic renal inflammations.

Granular casts (Figs. 12, 13) are also found in many of these chronic diseases, but, as a rule, the process is of a more active type than those in which exclusively hyaline casts are found. The granular casts also appear in the beginning of convalescence from acute nephritis before the activity of the inflammation has quite subsided.

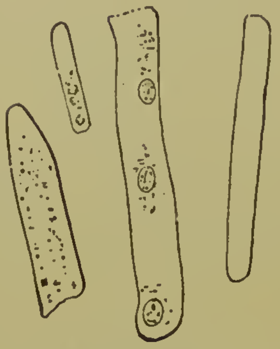

Fig. 10.—Hyaline casts (narrow and tolerably broad ones).

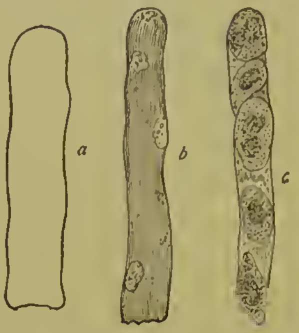

Fig. 11.—Hyaline casts: *b*, with leukocytes; *c*, with renal epithelium.

Blood-casts are found in acute nephritis and in renal inflammations due to traumatism either from the presence of a calculus or inflicted from without the body. In this form of nephritis the blood-casts gradually give place to the brown granular casts as the bleeding ceases. The latter are also seen in the urine of patients suffering from diseases associated with a greater or less destruction of the red corpuscles in the blood—such, for example, as scurvy. These pigmented casts, if made up of pure hyaline material with little or no granular structure, are sometimes classed by themselves and called fibrinous casts. Fatty casts are found in the chronic parenchymatous forms of nephritis.

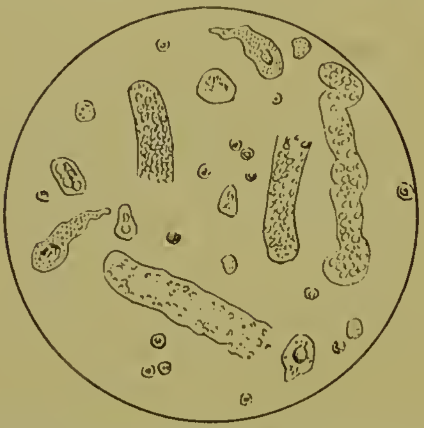

Fig. 12.—Granular casts with fatty globules; also, blood- and pus-corpuscles and epithelial cells.

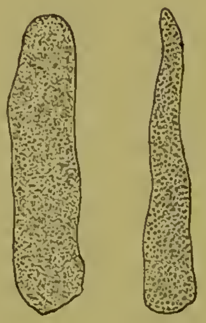

Fig. 13.—Finely granular casts.

Most of these forms of casts have epithelial cells adherent here and there to their surfaces, but in certain forms of disease these cells are so numerous that the casts are called epithelial casts (Fig. 14). In the so-called desquamative nephritis of scarlet fever, for instance, such casts are often found completely covered with renal epithelium, which adheres to them as they leave their tubules. In chronic interstitial nephritis, on the other hand, not only is there no desquamation of epithelium, but the casts themselves are small, scarce, and very hard to find. Sometimes a search of many slides, lasting several hours, will be necessary before a single characteristic cast can be discovered. These cases are sometimes hard to diagnosticate on this account, for, no matter how strong one's suspicion may be, the presence of casts is necessary in order to make the diagnosis justifiable.

The variety of hyaline casts called waxy (Figs. 15, 16) is found in far-advanced types of renal disease, in amyloid kidney, and also in many forms of nephritis as the fatal termination of the disease approaches.

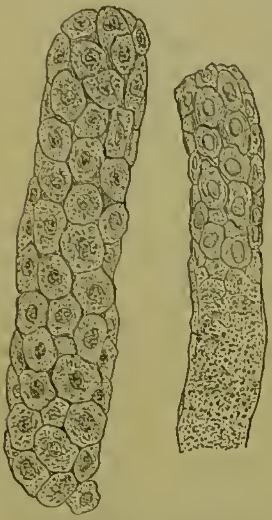
FIG. 14.—Epithelial casts.

Mucus.—Mucus when seen in any amount usually occurs in cystitis associated with decomposition of the urine. In such cases the mucus coagulates on standing, and forms a thick mucilaginous vehicle for the sediment which appears as a ropy gelatinous mass in the urine. Aside from this, mucus is rarely of clinical importance in the urine.

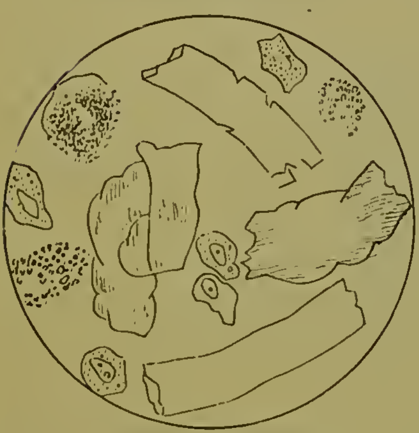
FIG. 15.—Waxy casts.

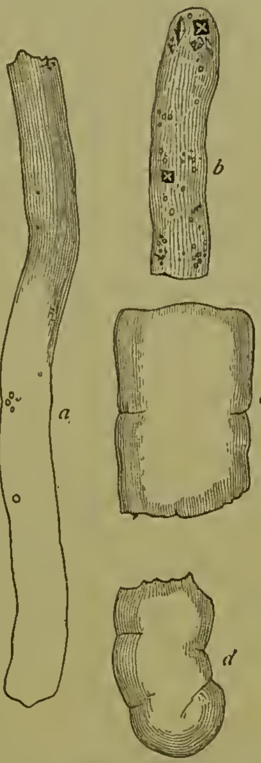

FIG. 16.—*a*, *c*, and *d*, waxy casts; *b*, a cast containing crystals of oxalate of lime (von Jaksch).

Prostatic Secretion.—The fluid secreted by the prostate, if present in an amount that makes it of clinical importance, can be seen floating in the urine (generally near the surface, for it is very light) as a stringy mass, more or less white and opaque-looking according as it has much or little pus mixed with it. Under the microscope it presents a fine meshwork of fibres, with which are intermingled rounded or oval cells already described in speaking of the epithelium of the deep urethra. Occasionally small refractive bodies, called sympexions by Robin, are seen. He describes them as opaline, transparent bodies, two millimeters in diameter, and with their edges more or less bevelled. They are thought to be the spermatic granules of normal semen held together in a mucous vehicle. Masses of them occasionally occlude the ejaculatory duct to an extent giving rise to what Reliquet[1] has described as *colique spermatique.*

[1] *Gazette des Hôpitaux,* 1874; 1879, p. 891.

If the prostatic fluid in the urine does not contain pus, it means that the condition is a more or less permanent congestion of the organ, which increases the amount of secretion, and is associated, as a rule, with considerable hyperesthesia of this portion of the urethra. It may be caused by increased activity of the organ due to urethral or vesical disease (giving rise to spasm of the part) or to sexual excesses. It results very commonly from urethral stricture, and not infrequently occurs in people suffering from nervous exhaustion. In the latter instance, although it is in most cases due to general nervous exhaustion, it invariably serves as one of the factors which retard recovery.

If much pus is mingled with a prostatic secretion, it generally means an inflammation of the prostatic urethra, usually of gonorrheal origin.

Vesicular and Seminal Secretions.—The secretions from the testis and from the seminal vesicles are always seen mixed together in the urine when seen at all. Were it not for this fact, the vesicular fluid could not be distinguished under the microscope from the prostatic secretion, as the presence of spermatozoa in the former and their absence in the latter is the only difference in the two fluids.

Vesicular and seminal secretions never occur in healthy urines, except in that voided just after intercourse and containing a portion of the ejaculated fluid left behind in the urethra. It is often of importance in making an accurate diagnosis to be able to estimate the relative amounts of vesicular and seminal fluids present in a given specimen, for in this way we are often assisted in distinguishing between an inflammation of the seminal vesicles and a spermatorrhea due to other than vesicular causes. Spermatorrhea and vesiculitis are often found together, one being a symptom or result of the other, and yet, on the other hand, they may be very distinct pathologically and need very different treatment. If the spermatozoa in the urine are found associated with a large quantity of pus and epithelial cells, the probability is great of there being inflammation of a seminal vesicle. Digital pressure on the vesicles through the rectum will often increase the vesicular elements in the sediment and thereby aid a diagnosis in doubtful cases. More often, however, the diagnosis of vesiculitis is not difficult, as there is abundant evidence of its existence outside of the urine.

New Growths.—Occasionally the sediment of the urine is of the greatest importance in cases of a suspected new growth in the urinary tract, as it will often contain small pieces of the growth, which can be readily spread out on a slide in a way to show its structure under the microscope.

Very rarely indeed pieces of false membrane deposited on the bladder-wall may be seen in a sediment and recognized under the microscope, but in the rare instances where such deposits occur they are usually so extensive as to be easily recognized in the urine by the naked eye.

Filaria Sanguinis Hominis.—Chyluria,[1] which is common enough in tropical countries, notably in India, Egypt, Brazil, and the West Indies, and which occurs more rarely in the Southern United States, is due to the activity of the parasite mentioned in this heading. The appearances are so characteristic that the disease cannot be confounded with any other, and it will suffice to describe the parasite and the appearance of the urine.

The parasite is a little thread-like worm, pointed at both ends, and is only active while the person is quiet, so the night is his working-time, and it is then that the milky appearance of the urine becomes marked, the day urine being comparatively clear. The milky urine looks like rather thick milk with specks and streaks of blood in it. It has a milky odor, especially when freshly passed, and quite soon coagulates into a more or less jelly-like mass. Under the microscope it appears very much like a specimen of milk.

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[1] Mastin: *Annals of Surgery*, Nov., 1888.

The parasite is seen in the urine or perhaps better in a drop of blood from the patient, moving quickly about if the specimen is freshly obtained, or quite dead if the specimen is an old one. In the one case of this disease which the writer has seen there was marked elephantiasis of the scrotum; and this is a very common accompaniment of the disease, the enlargement of the scrotum and legs being sometimes very great.

Echinococcus Cysts.—Echinococcus cysts are rare in the urinary tract, but occur occasionally in the kidney or bladder, and find their way into the urine.[1] The echinococcus heads and hooks may also be present.

Bilharzia Hæmatobia.—This name was given to a parasite discovered by Dr. Bilharz of Cairo, Egypt, in the portal vessels of the human subject, and subsequently found in the portal vein of the monkey by Cobbold. It has been shown that this parasite infests the mesenteric and vesical veins, and produces a disease endemic in Egypt and South Africa. Hematuria is a characteristic symptom of the disease.

Bacteria.—Two forms of bacteria need mention as being of diagnostic importance in the urine—the bacillus tuberculosis and the gonococcus.

The *bacillus of tuberculosis* (Fig. 17) is very difficult to find in the urine, so that, although it is of the utmost importance when found, as it definitely makes a diagnosis, still its absence is not to be considered as proving the absence of tubercular disease if there be clinical evidence of its existence. The bacillus is found in such small numbers in urine, and is so difficult to find, that cultures are usually taken from the specimen to be examined, and the bacillus is grown on gelatin and so made more easily manifest. This is the work of an expert bacteriologist. The bacillus can, however, with sufficient care and patience sometimes be demonstrated under the microscope. To do this properly the urine should be passed through a centrifugal apparatus (Fig. 18), and the sediment so obtained taken for examination. If this apparatus is not obtainable, the specimen should be allowed to settle for from twelve to twenty-four hours in a funnel-shaped vessel before it is prepared for examination. Then a little of the sediment is removed with a fine pipette, placed on a cover-glass, and spread out in a thin layer by being rubbed between two cover-glasses. Then proceed as follows:

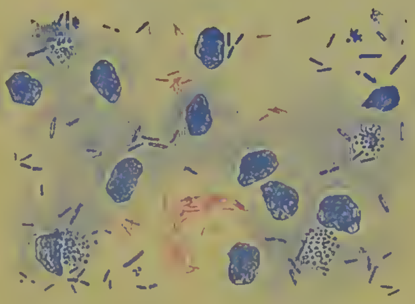

FIG. 17.—Tubercle bacilli in urine (von Jaksch).

(*a*) Dry the specimen on the cover-glass, passing it two or three times rapidly through a Bunsen flame.

(*b*) Stain by pouring on the cover-glass (held in forceps) a few drops of carbol-fuchsin solution, and then steaming over a flame for two or three minutes. Two such steamings are to be recommended. The carbol-fuchsin solution consists of 5 per cent. solution of carbolic acid in water, 100 c.c.; saturated alcoholic solution fuchsin, 10 c.c.; alcohol, 10 c.c.

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[1] A. M. Page: *Medical Record*, Sept. 21, 1895.

(*c*) Wash off the excess of staining fluid in water.

(*d*) Pour on the cover-glass (still held in forceps) a few drops of a solution of one to two grams of methylene-blue in 100 c.c. of a 25 per cent. solution of sulphuric acid in water.

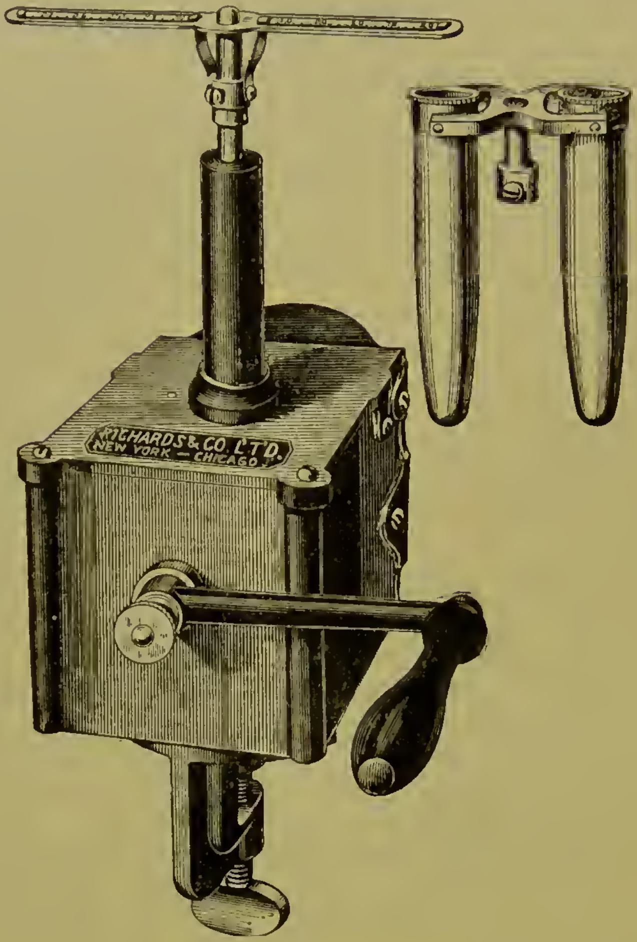

Fig. 18.—Centrifugal machine.

(*e*) Wash again and mount in water on a slide for immediate examination with $\frac{1}{12}$ oil-immersion lens.

This process stains the bacilli red on a blue ground, and is described as the easiest and most rapid method of procedure known to the writer.

In examining urines for the tubercle bacillus it must be borne in mind that the smegma bacillus frequently found in urines is almost identical in its morphology with the tubercle bacillus, and when such bacilli are found in large clumps in a specimen the possibility of their being smegma bacilli must be considered.

Gonococcus.—This germ was discovered by Neisser of Breslau in 1879, and is now considered the cause of gonorrheal inflammation, so that any urethral discharge which contains this organism is inoculated from without and is contagious. In fresh gonorrheal processes the germs are easily found, but in old and gleety discharges considerable care and patience is often necessary before the presence of the organisms can be demonstrated. They have been found in urethral shreds remaining from a gonorrhea acquired as long as four years previous to their discovery, and in such chronic cases it often takes but very slight irritative causes to start up an acute exacerbation of the inflammation.

They are small coffee-bean-shaped bodies, occurring in parallel pairs, and should always be demonstrated in the pus-cells before their presence is taken for granted. They generally occur in groups and inhabit comparatively few of the many pus-cells present. Their presence can be quite easily demonstrated as follows: Smear a thin film of discharge over a cover-glass with a platinum loop; dry in the air; pass two or three times through a Bunsen flame with the smeared side upward; then pour on the staining fluid, which consists of a few drops of a concentrated alcoholic solution of methylene-blue diluted with a dram or so of water; allow it to remain two or three minutes; then wash off the coloring solution with a stream of cold water and examine the cover-slip mounted in water just as it is or after drying and carefully mounting it in Canada balsam.

For a very thorough résumé of the characteristics of this organism the reader is referred to an article by Dr. J. H. Wright of the Harvard Medical School in *The American Journal of the Medical Sciences* for February, 1895, and to an article upon this subject in the present volume.

DISEASES OF THE PENIS.

BY B. FARQUHAR CURTIS, M. D.

MALFORMATIONS AND DEFORMITIES.

Absence, Reduplication, etc.—With the single exception of hypospadias and epispadias, congenital malformations of the penis are so rare as to possess little clinical significance. Absence of the organ has been observed in a very few cases, and probably some of these are really instances of rudimentary or of concealed penis, the organ being very small or displaced under the skin. But there are a few instances in which the penis has been entirely absent, besides the cases of fetuses so afflicted with other extensive deformities as to be incapable of life. In one such case the individual attained the age of twenty-seven years, and was in every other respect a well-formed man. The scrotum and testicles were normal, but the urethra measured only one and a half inches in length from the neck of the bladder, and opened directly into the rectum just within the anus. Urine and semen passed into the rectum, and micturition occurred every three to five hours. A fold of skin in the perineum running forward from the anus, with a warty protuberance at its anterior end, which was said to swell under sexual excitement, was the only representative of the penis. It is the rule in these cases for the urine to be passed into the rectum, the urethra opening directly into it, and in only one instance was there a perineal meatus. The great majority of the cases observed have been in infants, and Jacobson wisely suggests castration for these unfortunates before they grow up.

Rudimentary or **undeveloped penis** is not uncommon in its lesser grades, and in such it is not of great consequence, the individuals being, as a rule, sexually competent. In the higher grades of the deformity the other parts of the sexual apparatus also show lack of development, and more or less complete impotence results. Nothing can be done to improve this condition, although in those cases which lie on the border-line of competence general treatment directed to the sexual hygiene may be of service; and it must not be forgotten that some cases admit of great improvement, as in that cited by Wilson in which a man twenty-six years of age, with organs no larger than would be found in a boy of eight years, who had never had any erections previously, began to have erections and nocturnal emissions under the influence of a strong attachment, and when married soon after the parts increased nearly to the normal size within two years and he became the father of a family.

In the condition of **concealed penis** mentioned above the organ is more or less rudimentary and undeveloped, and is found under the skin near its normal situation; and in every case in which the penis appears to be absent a careful search should be made for it. The buried organ can sometimes be made to protrude by manipulation, but if this should fail it can readily be released by incisions, followed by some little plastic operation for providing it with a sheath by cutting flaps of skin from the neighboring parts. The penis should be freed as early in life as possible, in order that its growth may not be checked by its unnatural situation.

In some rare instances the penis has been found **twisted** upon itself in such a manner that the urethra made a half turn around the corpora cavernosa and appeared on the upper surface at the extremity of the organ, the glans also being turned upside down. Usually this condition is found associated with hypospadias or epispadias, and only very rarely is it seen alone. It requires no treatment.

Cases of **double penis** have been reported from time to time, but a simple true reduplication of the normal organ is as yet unknown, all of the cases on record being due to unusual modifications of other deformities. The most common variety is that in which a supernumerary limb is present in the perineum, and genitals are found on each side of the central malformation—for instance, in one case a shrunken supernumerary limb hung between the thighs of an otherwise well-formed man, with a scrotum on each side of it, one testicle in each scrotum, while in the natural situation were two perfectly formed penes. The urine and semen were discharged spontaneously from both organs, and either could be employed in coition. Sangalli has reported a case of double penis found at autopsy in a man fifty years of age who died of cancer of the stomach, in whom the pelvic girdle was open in front, and who had two urinary bladders, one for each ureter. The right-hand penis measured hardly five centimeters in length and had no urethra, the urethra from the bladder on that side opening just at the root of the penis underneath, as in hypospadias. The left penis was seven centimeters long, and had a prepuce and urethra, being capable of erection. The testicles were small, and the right one was ectopic in the groin. The left-hand bladder opened into the urethra of the right by a short transverse canal. Another variety is that well represented by the case of Van Buren and Keyes, in which two distinct penes of normal size and apparently well formed lay under a common sheath of skin up to the base of the glans. The glans was double, but on the left side the meatus was imperforate. There was another meatus at the penoscrotal junction which admitted the finger, and resembled the ostium vaginæ of a child, and some of the urine escaped from this opening. On one side of this aperture lay a fold of skin like a labium majus, and a testicle could be felt in it, but on the other side the testicle was ectopic, lying over the adductor longus of the thigh. The testicles were small, but sexual relations were possible. Another variety of double penis is the bifid organ, like those reported by Foster and Klebs and by Englisch, in which the penis was cleft in the glans and for some distance back, the urethra being split open and issuing at the bottom of the cleft. These are really cases of hypospadias, associated with cleft of the penis above for part of its length. Sexual intercourse was accomplished by slipping a broad thin band over the cleft glans, so as to hold the parts together.

One of the rarest of anomalies of the penis is the **congenital fistula**, of which but few cases are known. The fistula is a blind canal lying under the skin, usually opening near the corona glandis and running back along the dorsum subcutaneously for a variable distance, sometimes even beneath the pubic arch. The caliber of the sinus is from two to four millimeters. Although there may be some relation between this rare deformity and the rather common **sinuses** found near the meatus, both outside and inside of the urethra, they present marked differences and must not be confounded. Both, however, are of some clinical importance, as instances of gonorrheal infection of these sinuses are not unknown. The smaller sinuses are probably formed from elongated Tyson's sebaceous glands. They vary in depth from one-quarter of an inch to nearly two inches, and usually only admit a filiform bougie. Their mouths are generally found close to the meatus, and they run backward near the urethra (Figs. 19–22).

Sometimes the penis is found curved downward and adherent to the scrotum, and its growth and usefulness may be seriously interfered with. Although this condition is frequently associated with hypospadias, it may also exist with a well-formed urethra. The deformity is corrected by dissecting up the penis, as will be described under the operations for hypospadias, and this should be done early in life to prevent stunting of the growth of the organ, and also to escape the troublesome erections which complicate any attempt of the kind at a later period.

Hypospadias.—The commonest of all deformities of the penis is that known as hypospadias, which consists of a deficiency of the urethral floor extending over more or less of its length between the meatus and the perineum. The membranous portion of the canal is not subject to this deformity, although it is frequently involved in the opposite defect of epispadias. Hypospadias may be divided into three grades, according to its extent: the *glandular,* confined to the glans; the *penile,* affecting the glans and pendulous portion; and the *perineal,* in which the urethra is deficient in its whole length from the meatus to the perineum. But occasionally it will be found that there are two orifices, one in the perineum and the other farther forward, for instance, the defect showing itself only in the glans and at the seat of the posterior opening, the intervening portion of the urethra not being defective. Or still more rarely, the glans may be well formed, but the penile urethra imperfect.

The **etiology** of this malformation is not yet fully understood, the most commonly accepted theory being that it is due to an arrest of development, but there are many difficulties in the way of this hypothesis. Any theory should also explain the condition known as epispadias, which is still more difficult to account for, in order to be satisfactory. The developmental theory supposes that the penis is formed by the coalescence of the two lateral borders of the genital groove in the early days of fetal growth, these borders curving downward in such a manner as to enclose between them a canal, the urethra, and after their upper portions are already in contact any failure of union of the parts below would cause hypospadias. This arrest of development would leave the parts as they normally appear in that stage of growth when the sex of the fetus is uncertain, the external genitals of both sexes rather resembling the female type. If, on the other hand, the natural arrangement by which the rim of the pelvis closes first, and then the genital groove forms and closes below, be suspended, and the closing of the rim of the pelvis be delayed until the lateral borders of the genital groove approach each other and form the floor of the urethra, the roof of the urethra may fail to develop and the opposite deformity, epispadias, will be produced. Recently the study of congenital malformations has thrown some light upon the causes concerned in their production, and it appears that many if not all of them are due to interference with normal development caused by amniotic adhesions and bands. It is easy to comprehend how seriously the growth of any fetal part would be interfered with if it should become firmly adherent to the amniotic membrane covering it, instead of being separated from it by a layer of fluid, as should be the case normally. Parts which should tend to approach each other would readily be prevented from so doing by these adhesions. It is also apparent that any amniotic bands extending from one part of the fetus to another, and crossing the amniotic cavity, might come to lie in the interval between parts which should unite, and prevent that union by simple mechanical interposition.

Another theory has been advanced and warmly advocated by Kaufmann —namely, the supposition that all of the varieties of the deformities known as hypospadias and epispadias are due to failure of the normal development of the terminal portion of the urethra, resulting in urinary obstruction and infiltration, with sloughing and resulting cicatricial contraction of the parts. It is supposed on excellent grounds that the glandular urethra is formed by a canal which begins as a mere depression on the end of the glans, and gradually sinks into it, forming a canal which continues to increase in depth until it unites with the main portion of the urethra, which stops at the glans somewhere in the neighborhood of the corona. This mode of formation is similar to that of the anus and rectum, which are formed independently and unite at a comparatively late period. The time when urine is first excreted by the kidneys is not accurately known, but there are grounds for supposing that it may even antedate the time when the urethra becomes pervious by the junction of the penile and glandular portions of the canal. Should this be the case, the conditions would be similar to those of an impermeable urethral stricture in the same situation, and might result in urinary retention, infiltration of the periurethral tissues, sloughing of the roof or floor of the urethra, and the formation of abnormal openings in any direction, even to the extent of a complete hypospadias or epispadias. The deformity of the penis would be explained by cicatricial contraction. But the difficulty of accepting this theory is also great, for we know even less about the fetal secretion of urine than about the embryology of this region, not to mention the improbability that such pathological changes would take place without producing symptoms which would disturb the pregnancy.

Hypospadias is present to some extent in about one case to every three hundred males, but the severe grades are, fortunately, rare.

Clinical Appearance.—In the penile or glandular form (see Figs. 19–22) the meatus is a mere transverse slit in the skin, and is usually narrower than the urethra just within it. It is often so small and concealed by folds of skin as to be difficult to find, and such cases have sometimes been supposed to be instances of congenital occlusion of the meatus. Beyond the meatus, toward the tip of the organ, there is generally a shallow groove marking the situation of the absent urethra, which often contains one or more narrow sinuses, sometimes an inch or more in depth, with their orifices directed anteriorly, representing the lacuna magna and other follicles of the urethra. The foreskin is usually split or completely wanting in its lower (posterior) half, the fold of skin hanging like an apron over the dorsum of the glans, and often a concentric or helical whorl of the papillary ridges will be seen at each angle of the flap, resembling those which occur on the palmar surface of the tips of the fingers. The appearance suggests the fancy that the rows of papillæ or papillary ridges which were intended to run in parallel lines around the organ, being divided below, had sprung back, and the divided ends had coiled themselves up in this way on each side. The raphe extends from the scrotum along one side of the penis, finally joining the frenum, if one be present, along one side of the urethral furrow. In extensive hypospadias the penis is usually small, bent downward, and adherent to the scrotum (Fig. 23). The sex of the individual may even be in doubt, owing to the deformed condition of the parts in these cases, and the majority of so-called hermaphrodites are really males afflicted with hypospadias. The perineal urethral opening in these cases resembles the ostium vaginæ, the rudimentary penis represents the clitoris, while the halves of the divided scrotum, especially if the testicles be retained within the abdomen, simulate very closely the labia. Such individuals often present a female appearance, having a scanty beard, long hair, wide hips, high-pitched voice, and even well-developed mammæ. In some instances they have been brought up as females and lived as such all their lives, even sustaining sexual relations as women satisfactorily to themselves and their partners. A few individuals are described who have a well-developed penis, together with the perineal meatus, and who have been capable of sexual intercourse with both sexes, but these cases are very great rarities. In the false hermaphrodites only a thorough dissection and the discovery of a uterus and ovaries on the one hand or of testicles on the other can settle the question. True hypospadias is rare in the female, but it is occasionally found, and may be so extensive as to involve the neck of the bladder, differing in this respect from the same deformity in the male, which never involves the membranous urethra. Guyon says that there is no malformation of the floor of the male urethra which corresponds to that extreme deformity of the roof of the urethra that is found in exstrophy of the bladder with division of the sphincter.

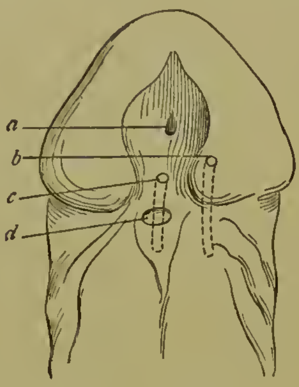

FIG. 19.—Glandular hypospadias: *a*, depression at normal site of meatus; *b*, sinus half an inch deep, admitting No. 5 F., just under skin; *c*, sinus three-fourths of an inch deep, admitting No. 5 F., under skin above urethra; *d*, meatus.

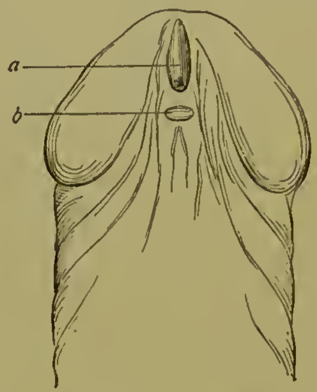

FIG. 20.—Glandular hypospadias: *a*, depression at proper site of meatus (with deep dimple at the bottom); *b*, the meatus.

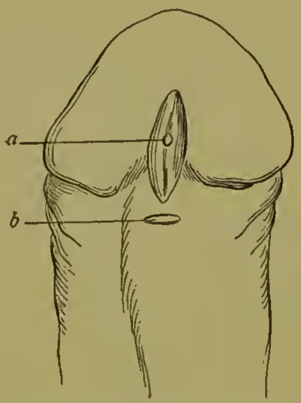

FIG. 21.—Glandular hypospadias: at *a* opens a narrow blind pouch which extends for one inch just above the urethra—*a*, lies between two well-marked lips; *b*, the meatus.

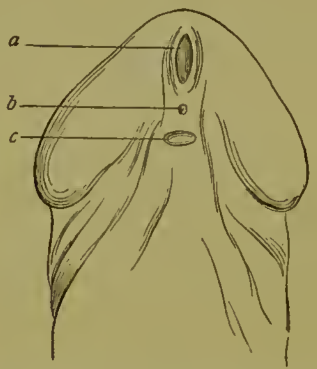

FIG. 22.—Glandular hypospadias: *a*, depression at proper site of meatus; *b*, sinus a quarter of an inch deep, admitting No. 1 F.; *c*, meatus.

The *functional disturbances* caused by hypospadias vary according to its degree. In the glandular form there is really no interference with function except a slight tendency to dribbling in urination on account of the peculiar meatus, but even in these cases the mental effect is often considerable, the patient complaining that he is not like other men, fearing to expose himself before them for fear of ridicule, and sometimes becoming hypochondriacal. In the more extensive forms of the malformation the disability is very great in both the urinary and the sexual functions of the organ. Urination in the erect position is difficult or impossible, and even in moderate cases the semen may not be deposited within the vagina in cohabitation, while the deformity or lack of development of the organ may render sexual intercourse impossible.

Treatment.—The cases of slight hypospadias require treatment only because of the psychical effect, but this is sufficiently important to warrant an attempt at a cure, especially as the little operation is without risk. As to the most suitable time for such an undertaking, it is well to wait until the parts are large enough to admit of easy manipulation, and this will scarcely be before the eighth year. If the operation is delayed too long, the after-treatment will be complicated by erections of the penis, and the healing of the wound may be jeopardized, but the technical difficulties of the operation are much reduced as the parts approach adult size. The best time is undoubtedly between eight and twelve years of age. It is well not to attempt too much at once, and in cases of any extent the freeing of the penis, the formation of the urethra in the glans and in the penis, and the closing of the abnormal meatus should be effected in separate operations. Even in the slight grades of the deformity it is well to make the anterior urethra first, and to reserve the closing of the meatus until later. The latter is a trifling operation, and can easily be performed with cocaine anesthesia in the adult, but partial failure is common, and complete union can be obtained only after several attempts.

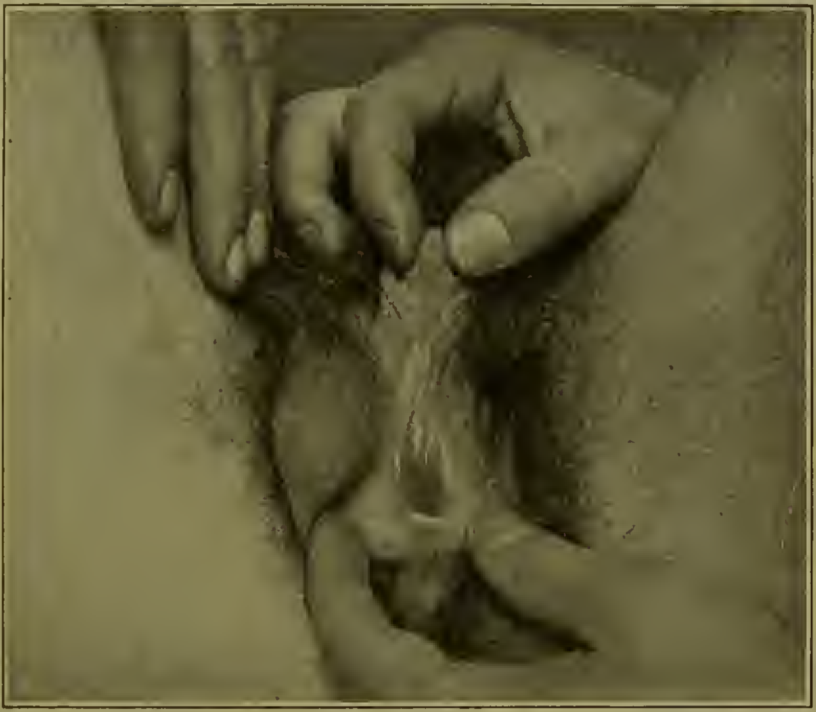

FIG. 23.—Perineal hypospadias.

If the penis is curved downward or adherent to the scrotum, the first step must be its rectification. This can generally be attained by a V-incision on the scrotum, the point directed downward. The triangular flap of skin is dissected free, the penis drawn upward, and the edges of the raw surface left by the retraction of the triangular flap united with sutures. Sometimes a superficial transverse incision through the body of the organ will also be necessary.

In the formation of the urethra the methods most in use are founded on the suggestions of Thiersch, first employed in operating for epispadias, and we shall illustrate them with figures of that operation. In order to form the glandular portion of the urethra two deep incisions are made, parallel to each other, along the margins of the shallow groove which is generally found marking the proper site of the canal. A short piece of a catheter, No. 15 Charrière, is laid between the incisions, and by this means the strip of mucous membrane lying between them is depressed, while the surgeon draws up the outer edges of the two incisions and unites them together over the catheter, freeing them, if necessary, by dissecting up a small flap on each side. The catheter is left in place for three or four days, or even a week if there is no inflammatory reaction. The sutures must be passed very deeply, and some coarse material should be employed, such as silver wire or silkworm gut, in order that they may not cut out, for the tension is considerable. The method about to be described for closing the penile urethra can also be employed in the glans, and in my hands it has given excellent results, the only objection being the slightly greater loss of blood owing to the larger surfaces involved in the formation of the flaps.

In order to form the penile portion of the urethra double flaps are employed. A flap (*b*, Fig. 24, *A*) is outlined on one side of the urethral furrow by a three-sided rectangular incision, the first part passing along one edge of the furrow for the necessary distance, and two short incisions being made at its ends, at right angles to the first, running away from the urethra. The other flap (*a*, Fig. 24, *A*) is outlined by an exactly similar incision, the long

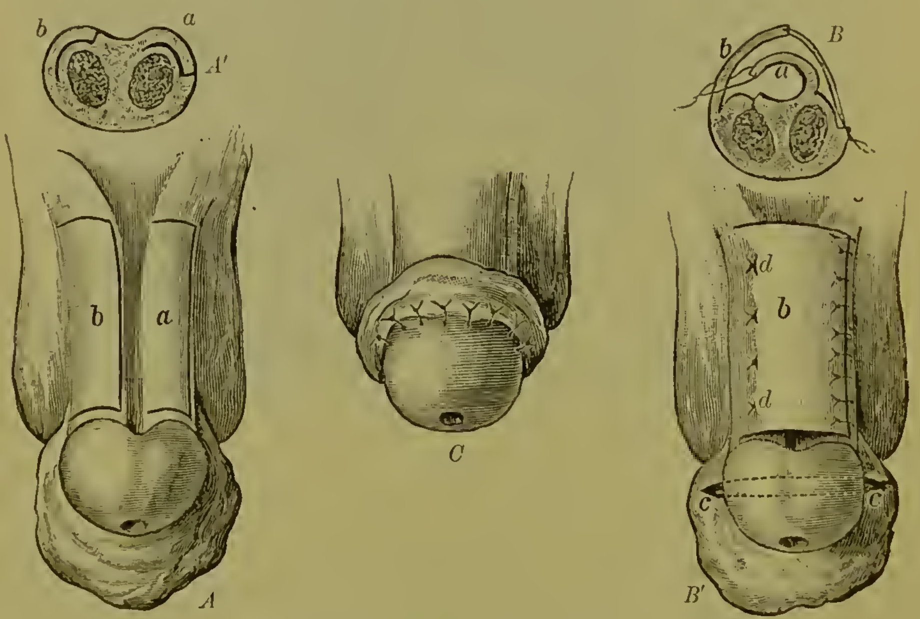

FIG. 24.—Thiersch's operation for penile epispadias, the glandular urethra having been restored. *A*, incisions outlining the flaps: *a*, flap with base toward the urethra; *b*, flap with base in opposite direction. *A'*, section through the penis and the flaps. *B*, section showing the flaps turned over and sutures inserted ready for tying. *B'*, the flaps in place, the flap *a* entirely concealed by the flap *b*; *c*, *c*, an incision through the foreskin, through which the glans is made to pass, and the redundant foreskin is secured by sutures to the anterior edge of the flap *b*. *C*, the operation completed.

central part being parallel with the other edge of the furrow, but at a distance equal to one and a half times the diameter of the desired canal, and the two short incisions at its ends being directed toward the urethra and continuing to its nearer edge. The two flaps are dissected up, the base of the first being distant from the urethra and that of the second lying directly at its edge, but both bases being directed toward the same side of the penis, either right or left. The flap with its base at the urethral furrow is turned over so that its raw surface is outermost, and its long free edge is then united to the incision made along the opposite edge of the furrow in cutting the first flap (Fig. 24, *B*, flap *a*). Two or three mattress sutures are passed through the edges of this flap, and both ends of each stitch being made to traverse the base of the other flap (*d*, Fig. 24, *B′*), they are united on the outer side. Or buried sutures of very fine silk can be used, being so introduced as not to penetrate the skin-surface of the flap or of the urethral furrow, the edge of the flap being somewhat inverted so as to enable them to be tied. The first flap is then drawn across the second, so that the raw surfaces of the two are in contact, reinforcing the inverted flap and covering the buried sutures if they are employed (Fig. 24, *B*). If possible, the edge of this flap should be united with the skin-incision made in cutting the other, but if the tension is too great to allow of this, it should be united to the raw surface at any point to which it can be easily brought. Sometimes the tension can be diminished by prolonging the incisions at the ends of this flap for some distance, in which case they should be made to diverge slightly in order to preserve the full width of the flap when it is drawn upon. It is particularly desirable in this operation to avoid great tension, for this would impair the circulation of parts which need all their vitality in order to resist the danger of infection to which they are unavoidably exposed by contact with urine. When the foreskin is redundant, a transverse incision (*c*, *c*, Fig. 24, *B*) may be made, the glans made to protrude through this opening, and the redundant portion thus displaced on the opposite side of the glans is employed to help close the deficiency, being united to the anterior border of the flap (Fig. 24, *C*).

It is, as a rule, wiser to abstain from attempting to close the abnormal meatus wherever situated, until the canal in front of it has been entirely formed and the wounds are healed, for this part of the plastic work is the one most likely to fail. Its chances of success are much better when the circulation has been fully restored in the surrounding skin, and, moreover, any attempt to close the meatus at the same time as the other operations jeopardizes their success, because of the exposure to urinary infection. In order to close the meatus a small but abundant flap is cut on any side of the opening, with its base directed toward the latter (Fig. 25). This flap is then inverted across the opening, so that its epithelial surface is directed toward the urethra, and secured in place after freshening the edges of the meatus by fine sutures (Fig. 25). The freshening of the edges should be liberal, and I have found it best to split them and draw the edge of the flap with deep sutures directly into the bottom of the cleft thus made. The raw external surface of the inverted flap may or may not be covered with a second flap from the neighborhood, but if there is abundance of material it is better to reinforce it in this way, on the same principle as that relied upon in constructing the penile urethra. The incision for the second flap is indicated by *a*, *b*, Fig. 25, and this flap should be rotated so that its apex, *a*, will be brought into the angle *a′*. Very frequently the attempt to close the meatus will fail in part, but it will at least reduce the size of the opening, and the operation is to be repeated in a similar manner after the wounds have healed. If it has partially succeeded and the resultant fistula is only about the size of a pin's head, this can usually be made to close by cicatricial contraction if its edges are thoroughly burnt with nitric acid, care being taken to protect the inside of the urethra in the neighborhood with vaseline before the acid is applied.

In the after-treatment of these plastic operations upon the urethra the problem of dealing with the urine is of vital importance, and the great differences which exist in the practice of good surgeons show how difficult is its solution. Some prefer to insert a catheter through a small perineal incision, while others drain the bladder by an instrument in the urethra. The former plan involves the risk of causing a traumatic stricture, and, radical as it appears to be, it does not keep the wound absolutely dry, some urine being very apt to find its way past the catheter. This leakage of urine is even more likely to occur along the side of the catheter introduced by the meatus, and although it can be reduced if the bladder be kept empty by maintaining a siphon action in the tube, it cannot be entirely prevented. A urethritis may also result if the catheter is left long in place. In children it is generally necessary to employ one of these methods, but in adults the following plan is more effective, although more troublesome: At regular intervals the urethra is irrigated thoroughly, a catheter is passed, the urine drawn off, the bladder irrigated with a weak solution of boro-salicylic acid, and the catheter withdrawn. The few drops of fluid which will inevitably follow the catheter on its withdrawal are thus not urine, but a harmless solution. The intervals must be suited to the frequency with which the patient wishes to pass urine, and the desire can generally be limited to three or four times in the twenty-four hours. Still another but less effective method, suitable for cases where the wound is near the end of the penis, is to have the patient irrigate the urethra before he passes water, and then urinate by holding the end of the penis under water in a cup set in an empty basin, repeating the irrigation at the end of the act. The urine is thus diluted at once as it escapes, and the overflow is caught by the basin.

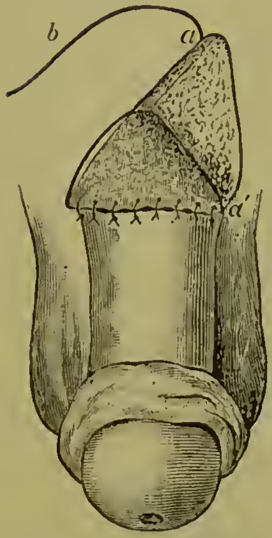

Fig. 25.—The method of closing the abnormal meatus after the operation for epispadias.

After the urethra has been formed by these methods it is necessary to pass a sound to the bladder every three or four weeks during the first six months, or until it is certain that no contraction is taking place. If there should be any tendency to contraction, it can usually be controlled by the weekly application of the sound for a few times.

Epispadias.—In the deformity known as epispadias (Fig. 26) the roof of the urethra is lacking, the corpora cavernosa not being in contact with each other above, and the canal is only represented by a shallow groove on the dorsum of the penis, and even this indication of it may be absent. The union of the corpora cavernosa below the urethra is, however, more apparent than real, for the floor of the urethra can be forced downward into close contact with the skin on the under side of the penis, displacing the corpora to either side. This deformity is much rarer than hypospadias, and, like it, is found in three grades—the *glandular*, the *penile*, and the *complete* form in which the pubic arch remains open, the cleft runs back into the neck of the bladder, and the bladder itself may be extroverted. The first form is exceedingly rare, only three such cases being known. The penile form is also seldom seen, the roof of the urethra being generally defective throughout if absent at all.

Sometimes, however, the glandular part of the urethra is well formed and pervious, but the penile portion of the roof is wanting; or a well-formed penis may even coexist with exstrophy of the bladder, only a slight notch being found in the posterior end of the roof of the urethra close to the neck of the bladder. When the glandular portion is involved in the deformity, the foreskin is also divided above and hangs like an apron from the frenum under the glans. The etiology of this curious deformity has already been discussed together with that of hypospadias. The commonest form of hypospadias is the glandular, while in epispadias the defect is very rarely limited to the glans, but exstrophy of the bladder is a very common complication, as if the forces which produced hypospadias first showed themselves anteriorly, finding their best opportunity in that part of the urethra, while those which produce epispadias were most effective posteriorly, and found the neck of the bladder and the penile urethra more vulnerable than the glans. Perhaps epispadias is to be looked upon as a secondary deformity, a sequel of the failure of the pubic arch to unite, rather than as an independent malformation, while hypospadias should be considered as the failure of the natural closing process of the floor of the urethra, the forces which should normally close it dying out as they advance toward the glans before their work is complete.

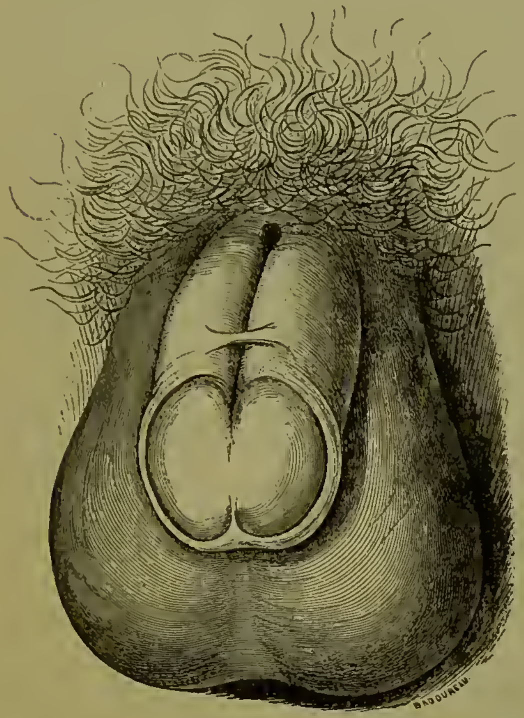

FIG. 26.—Complete epispadias.

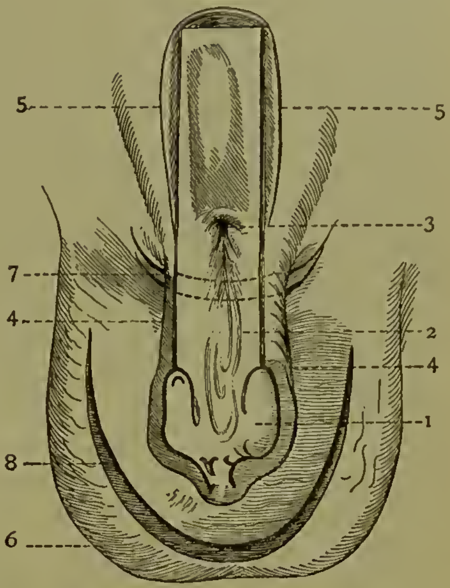

FIG. 27.—Dolbeau's operation for epispadias: 1, the glans; 2, the urethral furrow; 3, the entrance to the bladder: 4, 4, incisions made on each side of the urethra; 5, 5, the flap cut from the skin of the abdomen, to be turned down and sutured to 4, 4; 6, incision outlining flap on scrotum, 8; 7, button-hole in base of 8, through which the penis is to be thrust.

The condition of the parts in complete epispadias is rendered worse by the small size and upward curvature of the penis. The penis often seems a mere button of flesh which is drawn into and partially fills the opening in the neck of the bladder, in some cases apparently acting as a valve and assisting in the retention of the urine. The functional results of the deformity are not merely the loss of the proper canal for urination, but, owing to the usual association with a deficient sphincter, if not with extroversion of the bladder, incontinence of urine is the rule. Coition is almost always impossible, and fecundation can be accomplished only in the very rare glandular form, the semen otherwise not being deposited in the vagina. It is said that the sex of the individual may be uncertain in extreme cases.

In the attempts to remedy this deformity by operation the urethra may be formed, according to Dolbeau, when the bladder is not extroverted, by cutting a narrow flap from the abdomen and turning it down over the dorsum of the penis, with the skin-surface toward the urethral furrow. Lateral flaps are then dissected up from each side of the penis, drawn together over the first flap, and united in the median line so as to cover its raw surface, or a flap is cut from the scrotum, with its base at the root of the penis, and a button-hole incision is made in the latter situation through which the organ is to be thrust, and the scrotal flap is then secured by sutures over the raw surface of the other flap (Fig. 27). Or flaps may be formed, according to Thiersch, as in the operations described for hypospadias, and this method can be employed also when there is exstrophy of the bladder. With the treatment of the last-mentioned complication we cannot deal here. The results of these operations are not so good as in hypospadias, as the development of the penis has generally suffered far more than in that condition and there is less material for flaps. The functional results in regard to coition are also much less satisfactory.

Malformations and Contractions of the Meatus.—Besides those malformations of the meatus that accompany hypospadias and epispadias there are various others (Figs. 28–30)—none, however, of any clinical importance except its absence or undue contraction. An imperforate meatus is usually closed only by a very thin membrane, formed of the epithelial cells growing between the prepuce and glans, which is readily punctured or torn through. This is a very common deformity, but the more extensive malformation in which the glandular urethra is partly absent is very rare and

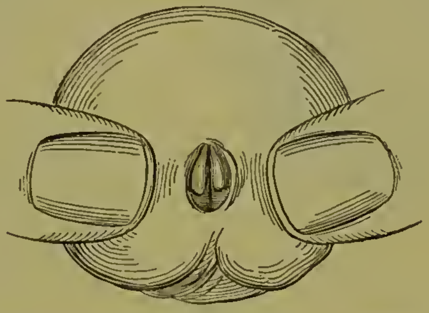

Fig. 28.—Meatus with two internal folds of mucous membrane, resembling the labia minora of the female vulva.

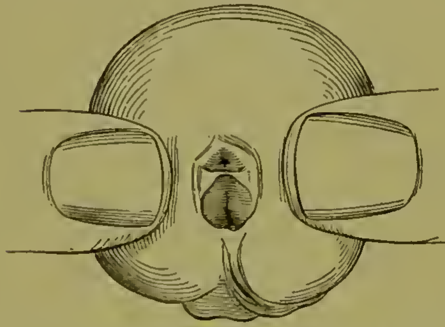

Fig. 29.—Meatus with blind shallow depression just above the urethra.

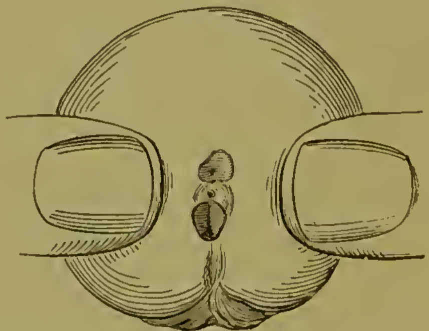

Fig. 30.—Meatus with depression similar to that in Fig. 29, and a long, narrow sinus opening between it and the urethra.

more difficult to treat. If there should be any difficulty in finding the end of the imperforate urethra, it is best to open the canal in the perineum (where it will sometimes be found fully distended with urine), to pass a sound forward, and to cut down upon that instrument at the most anterior point reached. This opening must be made quite free, and the mucous membrane sutured to the skin in order to secure prompt union and the avoidance of cicatricial contraction. In cases of hypospadias, also, the opening is often too narrow, and it should be enlarged by an incision backward, and cicatricial contraction avoided by sutures so placed as to cover the raw edges, or by a small flap cut from the skin near by and secured in the angle of the incision for the same purpose.

A very small meatus may be a congenital defect, when it is apt to be associated with a long, narrow foreskin, or it may be the result of cicatricial contraction from ulceration or wounds. Among the Hebrews many apparently congenitally narrow meatuses are really cicatricial, being caused by improper circumcision, the tip of the glans having been removed with the knife during the operation, and contraction following. Whatever the origin, a narrow meatus is often the cause of serious mechanical and nervous consequences, such as hernia, hypertrophy of the bladder, nocturnal involuntary micturition, and many reflex nervous symptoms; but all of them will be considered under the head of Phimosis, which is a more common cause for these disturbances.

The **treatment** of a narrow meatus consists simply in incision, followed by the occasional passage of a sound until the wound heals, and afterward if there be any tendency to recontraction. The incision should divide the most constricted part, and this is sometimes to be found just within the edge of the opening. A narrow probe-pointed bistoury is introduced for half an inch or so, and made to cut on the floor of the urethra as it is withdrawn, the tip of the finger outside pressing that part up against the edge of the knife. In cases of very close contraction a notch may be made above also. The edge of the meatus should be saved, if possible, for it is often quite elastic, and will admit a good-sized sound if the obstruction within it be overcome. The spout-like shape of the end of the urethra, owing to the fact that the meatus is naturally smaller than the canal, is important, for if it be lost there is apt to be an unpleasant dribbling after urination. This shape, however, must often be sacrificed in order to obtain an opening of proper size.

(For further details see article on Diseases of the Urethra.)

Malformations of the Foreskin; Phimosis and Adhesions.—The normal development of the prepuce begins in the third month by the appearance of a fold of skin behind the corona, which grows forward, its internal layer becoming adherent to the glans as it progresses, owing to the softness and defective cornification of the cells, although both of the surfaces which are in contact are covered with flat epithelium. There is thus a layer of cells between the two parts of double the usual thickness, amounting to about eight cells. When the child is born the foreskin normally covers the glans and is adherent up to the edge of the meatus. During the first years of life the adhesions give way, partly by advance in the cornification of the cells making its way from without inward, partly from the traction which takes place on erection, until finally the prepuce can be drawn back over the glans. The opening in the prepuce at birth is usually too small to allow of its retraction even if there were no adhesions, but the orifice stretches as the adhesions gradually yield.

If the normal separation of the foreskin from the head of the penis does not occur, it can as a rule be brought about when the preputial orifice is not too small by drawing the prepuce strongly backward and separating the adherent surfaces by some blunt instrument, such as a flat probe. Occasionally it will be found that the adhesions are too dense to allow of this, and it may even be necessary to dissect the prepuce from the glans with the knife, cicatricial tissue having formed in consequence of some previous inflammation. It has been recommended to cover the raw surface produced by this dissection by a plastic operation, but it will usually be found sufficient to invert the preputial flap which has been formed and to secure its edge in the neighborhood of the corona. This may make rather a bulky and short prepuce, but will at least prevent it from forming fresh adhesions with the surface of the glans, which it is otherwise sure to do.

Phimosis is that condition of the prepuce in which the orifice is too small to admit of retraction over the glans. It is usually congenital, and is generally found combined with redundancy of the prepuce and with persistence of the infantile adhesions. In some rare cases the orifice may be entirely wanting. It may be noted in passing that the opposite condition of a short or absent prepuce is a rare deformity. Phimosis may be an acquired condition, being produced by disease or injury, cicatricial contraction narrowing an opening which would previously have given passage to the glans, and also causing the formation of adhesions. In every case of adherent prepuce in infants in whom a balanitis appears the foreskin should at once be forcibly retracted, and many a case of phimosis can thus be prevented. In congenital phimosis the meatus is almost invariably contracted also, and even in the acquired form it is apt to be narrowed. The results of this condition are twofold—being in part purely mechanical, and in part consisting of nervous disturbances set up more or less directly. The mechanical consequences are seen when the size of the orifice in foreskin or meatus is sufficiently reduced to obstruct the flow of urine, and are similar to those observed in any tight penile stricture of the urethra, such as distention and hypertrophy of the bladder, dilatation of the ureters, and even disorganization of the kidneys from the great backward pressure. Hematuria and other symptoms resembling those of vesical calculus may be present. When the obstruction is mainly at the preputial orifice the foreskin may be ballooned out by the urine, which can only issue from the opening drop by drop, and the patient often has to assist the evacuation by pressure on the distended prepuce with the hands. Another mechanical result of the obstruction is the occurrence of hernia, which is very common in infants with phimosis, and conversely phimosis is often observed in infants suffering from hernia, being especially frequent in those with multiple herniæ. The abdominal pressure exerted in the straining to evacuate the urine and in the crying which often accompanies the effort in such children is sufficient to prevent the firm closure of the natural hernial openings and to cause the yielding of those which have already closed. Prolapsus ani is also not infrequently observed as a result of this straining.

Another consequence of the mechanical obstruction is the obstacle which it offers to cleanliness, resulting in a balano-posthitis induced by the retention of the "smegma," which consists of the secretion of the glands of the lining membrane of the prepuce and the covering of the head of the penis, together with the dead epithelial cells from those surfaces, the decomposition of which is hastened by the admixture of urine. This inflammation in turn narrows the opening by subsequent cicatricial contraction and aggravates the condition. If any venereal infection be acquired by persons with phimosis, the pus collects under the foreskin and the inflammation may be very intense, resulting often in extensive destruction of the parts by ulceration or sloughing, or in a cellulitis or erysipelas which may involve the entire organ. Preputial calculi are also occasionally found in cases of phimosis, and sometimes attain a great size. These may be formed by calcification occurring in the masses of smegma and dead epithelium, etc., or they may form from urine retained in the dilated foreskin; or, finally, they may originate above and be carried down as gravel with the urine into the prepuce.

Certain evil results of phimosis are produced through the nervous system and react upon it. These may be in part due to the mechanical condition of obstruction, but they seem chiefly dependent upon the nerve-irritation caused by the presence of the adhesions and the decomposing matters under the foreskin. This nervous irritation is partly shown by urinary disturbances, such as frequent micturition, involuntary micturition, especially at night, and difficult urination from spasmodic contraction of the neck of the bladder; but its effect in sexual symptoms is much more marked. In infants the sexual irritability declares itself by priapism, the early establishment of the habit of masturbation, with restlessness, sleeplessness, and even convulsions. In the adult the sexual erethism causes masturbation, excessive sexual intercourse, undue irritability of the parts, and produces premature ejaculation, backache, and the whole train of secondary consequences which may follow this sexual disturbance. There are many cases in which distant reflex effects have been observed, such as disturbances of vision which appeared closely dependent upon phimosis and have disappeared immediately after circumcision, muscular contractions, and loss of muscular co-ordination in the lower extremities. It has even been claimed by Sayre that hip-joint disease might be a remote result of phimosis.

The **treatment** of phimosis is limited to the enlargement of the preputial orifice. Dilatation of the preputial opening by any method is only a half measure, involving almost as much suffering as the cutting operation, acting very slowly, not correcting the redundancy of the prepuce which is so common a complication, and which in itself is capable of producing many of the results of phimosis; and this treatment is necessarily limited to the mildest cases. The best operation for the enlargement of the opening is the ancient one of circumcision. A very simple substitute for it is the dorsal incision, but this is not satisfactory, because it does not thoroughly expose the parts, and because it leaves them so deformed that a subsequent operation is generally necessary to make them presentable. The dorsal incision is made through the entire thickness of the foreskin in the middle line by a stroke of a strong

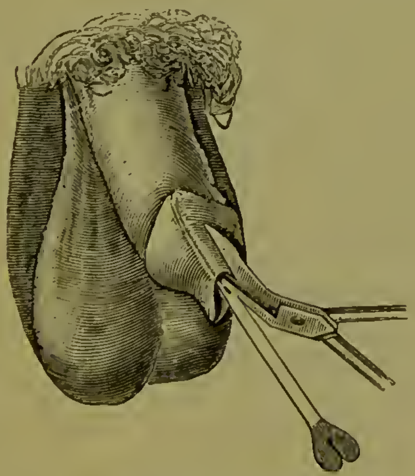

FIG. 31.—Dorsal incision for phimosis.

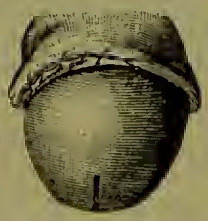

FIG. 32.—Result after lateral incisions for phimosis, with subsequent trimming and suture.

pair of scissors (Fig. 31) or of a sharp knife introduced along a director previously slipped in up to the corona, the knife being made to transfix and cut outward. Taylor recommends a modification of this in which an incision is made on each side instead of the central median incision, and the prepuce is thus divided into two halves, so that by lifting the dorsal half or flap upward and turning the frenal flap downward the head of the penis can be completely uncovered. On recovery another little operation must be done, consisting, when the dorsal incision has been used, in cutting off the corners on each side of the incision, and perhaps the frenal portion of the prepuce as well. When Taylor's bilateral incision has been employed the second operation should reduce the size of the two flaps, so as to make the organ look as if a circumcision had been performed in the first place (Fig. 32). The dorsal incision can be employed to advantage in infants who have a scanty but close-fitting prepuce. But with this exception these two operations are to be looked upon as operations of necessity, and should be limited to those cases in which there is very intense inflammation, and in which it is desirable to limit the size of the wound and the surfaces thus exposed to fresh infection. Formal circumcision is the operation of choice and is applicable to almost all cases.

In adults circumcision can easily be performed with local anesthesia, preferably induced by cocaine, but in nervous individuals and in children a general anesthetic is desirable in order to obtain the quiet necessary for a neat closure of the wound. In very young infants it is perhaps best to operate without any anesthetic, for they will suffer as much from struggling against its administration as from the operation itself, for the latter lasts only a few seconds if deftly done, and the introduction of sutures is unnecessary in such cases. When cocaine is employed the hypodermic syringe is filled with a 4 per cent. solution, the needle is inserted in the skin of the dorsum in the median line over the corona, and an injection is made in the skin, its correct situation being shown by the appearance of a welt like that of urticaria. It is very essential to have the injection just in the derma, and not in the subcutaneous tissue, if full anesthetic effects are to be obtained. The point of the needle is to be kept in the skin, and made to penetrate it laterally, first on one side and then on the other, until at least one-half of the circumference of the organ has been traversed. It is then withdrawn and reinserted at a point directly opposite the first on the under side of the penis, and from this new point it is worked laterally in the same way. With a needle of ordinary length the whole circumference can be easily reached from these two points of entrance. A few drops are then injected into the subcutaneous tissue along the same line, and, if the adhesions are very dense, the operator should try to distribute the injections as near the preputial lining as possible, or even to make them directly into the thickness of that membrane. Fifteen minims is the most that will be required, and often half that amount will answer. The effect of the anesthetic can be much prolonged by tying a strip of bandage moderately tight around the root of the organ after the injection has been made. This also lessens the liability to constitutional absorption, and the only objection to it is the slightly increased venous hemorrhage.

It is understood that the parts have been carefully cleansed and the usual antiseptic precautions have been observed before the cocaine is introduced, if that be the anesthetic employed. The foreskin is retracted as far as possible, and the edge of the preputial lining seized just at the orifice above and below with toothed forceps or pointed artery clamps (Fig. 33). The organ is then released by the hand, and traction is made by the forceps, putting the inner layer of the foreskin on the stretch, the outer layer being at its normal tension. A long, slender clamp is then applied to the foreskin just beyond the glans, being held in the sagittal plane, directed obliquely forward and downward, so as to lie parallel with the dorsum of the glans and to include more of the dorsal than of the frenal part of the prepuce. A special clamp is made for this purpose, but any instrument with two shanks which come close together, such as a pair of scissors with long straight handles, may be employed, although the operator must be prepared to have them slip off as he completes his incision. When the clamp has been applied the forceps which hold the prepuce can be taken off or allowed to hang, and the prepuce is held by the fingers while a narrow, sharp-pointed bistoury is made to transfix the prepuce just in front of the clamp and cut upward. The edge of the blade is reversed and the remainder of the prepuce cut away, the knife being directed forward just as it is severing the last shred, so as to produce a little point of skin in the flap at the frenal border. The clamp is then released, when it will be found that the skin retracts at once to the level of the corona, while the mucous membrane lining still remains over the glans, with its raw external surface exposed by the retracting skin. Some surgeons prefer to cut away the foreskin on the proximal side of the clamp, that is, on the side toward the glans, because they claim that the instrument bruises the edges of the incision so as to lessen the chances of primary union. The novice, however, should adhere to the first method, for there is danger of wounding the glans with the knife in trying to pass the latter between that organ and the clamp. Other surgeons prefer to use a scissors instead of a knife in cutting away the foreskin, and there is no objection to this, provided that a very sharp and strong pair be employed and used with a very quick stroke, otherwise the soft tissues are apt to slip away from their edges and the incision is very uneven.

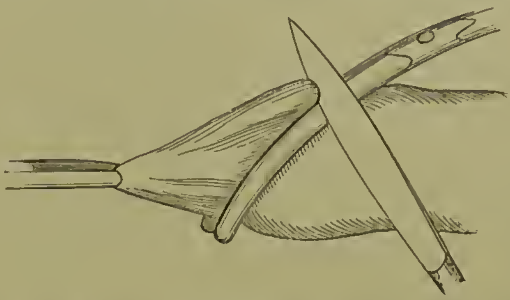

FIG. 33.—Method of performing circumcision with clamp.

The inner layer of the prepuce has next to be divided, and this may be done with a pair of straight scissors, cutting it up in the middle line along the dorsum all the way to the coronal groove. Some surgeons prefer to give a Y-shape to the upper end of this incision, as the little triangular flap thus left facilitates the adjustment of the edges of the two layers at this point. In infants, especially if no anesthetic is employed, this dorsal division of the mucous layer can best be done by seizing it on each side with the finger and the thumb-nail and tearing it apart upward, the same movement generally sufficing to separate the adhesions, so that the flaps can be quickly rolled back from the glans. If the adhesions are strong, they must be broken down by the nail or by some blunt instrument, taking care not to injure the surface any more than absolutely necessary. Rarely is the use of the knife needed for this purpose, and it should be avoided, because it is difficult to follow the correct plane; and if the surfaces are injured, troublesome oozing may occur and the healing may be delayed by the excoriations produced. The corners of the two flaps thus made in the mucous membrane lining are rounded off by the scissors, and if the operation has been properly performed, it will be found that the edges of the skin and mucous layers fall together nicely, and that the frenum has not been shortened. The hemorrhage from the operation is trifling, but a ligature may be needed near the frenum. In infants sutures will be unnecessary, for the little wound heals so readily, and in cases of venereal infection they should be omitted, as primary union cannot be hoped for. In all other cases, however, the healing of the wound will be much more rapid if they are employed. The best material for sutures is fine silk, and in introducing them the needle should pick up just the edges of the skin and mucous layer, the loose cellular tissue between them being pushed back as the knot is tightened. The sutures should be interrupted, for the continuous stitch leaves a long thread to be removed, and may cause some constriction if made continuous entirely around the organ.

A strip of iodoform gauze wound around the penis, secured by two longitudinal strips of plaster carried along the sides of the organ and up on the abdomen, and a circular strip around the whole, or by painting the entire outside of the dressing and the neighboring skin with collodion, will be the best dressing until all oozing has ceased. The meatus should be left free for urination. After twenty-four hours the dressing may be removed and the wound painted with collodion after being washed with alcohol. Union will generally be complete by the time this coating detaches itself, and the stitches can be removed at any time after the fourth or fifth day.

A condition resembling phimosis is that produced by a frenum which is too short to permit retraction of the foreskin without force, even when the orifice is ample and there are no adhesions. The frenum pulls the glans sharply downward when the foreskin is drawn back, and if much force is employed the bridle may be torn across, occasionally setting up a severe hemorrhage. This condition also interferes with sexual intercourse, rendering it painful and liable to cause abrasions if not rupture of the frenum, and these wounds greatly increase the danger of venereal infection. The short frenum has also been known to cause reflex nervous disturbances, with undue sexual excitability and premature ejaculation.

The frenum is easily lengthened by making a V-shaped incision across the band, with the base of the V directed toward the meatus, the little flap thus formed being then slid toward the meatus sufficiently to relieve the tension even in erection, and the edges of the wound left by its retraction being sutured. When there is abundant material another method of elongating the frenum consists in dividing it transversely, pulling the wound widely open, and uniting the angles at the ends of the incision across the center by a stitch, thus converting the transverse wound into a longitudinal one and lengthening the frenum.

Paraphimosis.—Paraphimosis is the condition produced when the preputial orifice is narrow and the prepuce has been forcibly drawn back over the glans, and its return is prevented by the arrest of the narrow opening behind the corona. Great edema and swelling of the glans follow from the obstruction to the circulation which is thus caused. The prepuce may slip back as a whole, and then its margin will be found deeply buried behind the prominence of the corona. But more commonly the foreskin is more or less everted as it is retracted, and then its internal layer forms a thick edematous fold directly behind the corona, while the narrow preputial margin will be found in a deep furrow behind this fold. Beyond the furrow will be seen another fold formed by the cutaneous layer of the foreskin. When edema and inflammation have swollen the parts the glans is found bent more or less acutely toward the dorsum by the great swelling of the loose tissues about the frenum, while just above the glans will be seen a series of transverse edematous and reddened ridges and deep furrows.

This condition is produced in various ways, sometimes by boys in play, sometimes during coitus, and sometimes in attempts to uncover the glans for the examination or treatment of some pathological condition under the foreskin. Even when the preputial orifice is not so tight as to render retraction very difficult, if it is left retracted too long the circulation in the parts beyond may be interfered with sufficiently to make them swell, so that they can no longer be made to re-enter the foreskin, and therefore paraphimosis is possible even in cases of only moderate contraction of the orifice. It is well to warn all patients with venereal disease who have any narrowing of the foreskin against forcible retraction, and against allowing the prepuce to remain retracted for any length of time.

If this condition be left unrelieved, it may result in gangrene of the glans in whole or in part, but such a termination is fortunately rare, for before it occurs the constricting bands generally lose their vitality and slough, leaving narrow transverse ulcers at the bottom of the deep grooves, but allowing the circulation of the parts beyond to return. These ulcers and sloughing surfaces become infected, and the severest forms of cellulitis or erysipelas may follow, with extensive sloughing, which not infrequently invades the urethra and produces large penile fistulæ. If the constriction is not severe enough to cause sloughing, the parts may become habituated to the impeded circulation, and the edema gives place to new connective tissue, which renders the hypertrophy and deformity of the organ permanent.

To reduce a paraphimosis, the penis should be grasped between two of the fingers of each hand placed so as to interlock behind the constriction and draw the foreskin forward, while the thumbs make lateral and direct pressure upon the glans and swollen portions, trying to squeeze out the blood and serum and so reduce the swelling, and finally to press the glans backward through the constricting ring (Fig. 34). Or one hand may grasp the penis firmly (Fig. 35), while concentric pressure is made upon the swollen parts with the tips of the fingers of the other hand, backward pressure being made when it is felt that the swelling is lessened. If the thumb-nail or a stout piece of wire bent like a hair-pin can be introduced under the constricting edge of the foreskin, the latter can sometimes be worked forward by sweeping lateral movements with the nail or wire. It is well to apply a little oil to the parts near the constriction, but it should be limited in amount, as it will

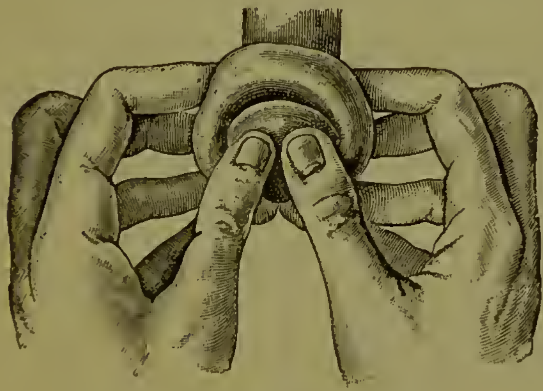

FIG. 34.—Reduction of paraphimosis.

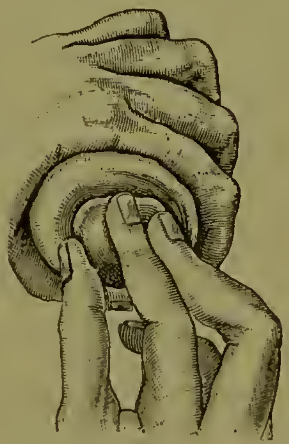

FIG. 35.—Reduction of paraphimosis.

render them too slippery to be manipulated. Sometimes an elastic bandage or strapping with plaster will reduce the swelling, and scarification and multiple punctures can be employed for the same purpose. Soaking in very hot water will also assist. If all of these attempts fail, the constricting band should be divided, and it is best to do this by a single dorsal incision in the median line (Fig. 36), which should be quite free, for the constricting band generally lies at a considerable depth. To try to divide this band subcutaneously as one would operate for a tenotomy is a mistake, for considerable cutting must be done before the band is divided, and this large wound is more liable to troublesome infection if made by a puncture through the skin than if the latter is freely incised. Even a large incision will appear small when the swelling subsides after reduction. A general anesthetic will usually be necessary for the maneuvers of reduction, but if not cocaine must be inserted for the incision. In the chronic unreduced cases massage should be added to the measures already suggested.

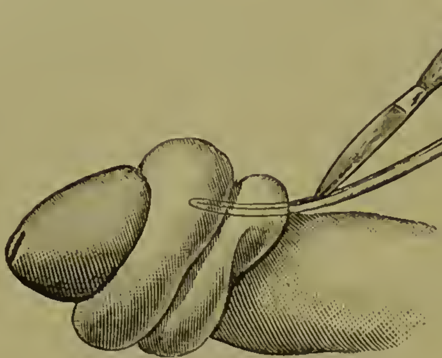

FIG. 36.—Division of paraphimosis.

INJURIES.

Owing to its sheltered position the penis is rarely severely injured, and yet it does not entirely escape. Contused, lacerated, incised, punctured, and gunshot wounds, and even burns, occur, and do not materially differ from the same injuries elsewhere, except in the profuse hemorrhage which may follow when the cavernous tissues are injured—whether it be external bleeding or the formation of large hematomata. There are numerous instances where insane individuals have themselves cut off the penis or where this mutilation has been inflicted in savage warfare. In the recent Abyssinian-Italian war many such cases were noted, and about one-third of the individuals survived, the hemorrhage stopping spontaneously. The tissues of the penis are well endowed with vitality, except the skin, and sloughs seldom occur after injury unless it be accompanied by urinary infiltration—a complication which is naturally quite common after these accidents.

Any two of the three erectile bodies may be entirely severed, and yet the circulation will be sufficiently sustained by the third to prevent gangrene. The extensive scars which follow such injuries, however, damage the erectile power. The hemorrhage from the erectile tissues can be controlled by firmly closing their capsules by deep sutures.

The most common injury to the penis is rupture of the frenum, which usually occurs during coitus in individuals with a short band, and this trifling accident has been known to be followed by fatal hemorrhage.

Another not uncommon injury is the so-called fracture of the penis—

that is, a rupture of the fibrous coat of one of the erectile bodies during full erection. This accident may occur as the result of awkward coition or of an intentional blow, and one curious case is on record in which it resulted from forcing the erect penis into the clothing while dressing. But the injury is also frequently produced intentionally by striking the organ or by bending it forcibly in the hands in order to straighten the curve caused by "chordee" or by a chronic strictured urethra. The urethra itself is, fortunately, rarely injured, for suppuration is then inevitable. The injury causes a hematoma on the side where the fibrous tunic has given way, and the swelling should be treated by compression with a bandage and the applicaton of ice. Urethrotomy should be done at once if the urethra is also ruptured. This injury is very apt to leave behind it a loss of erectile power or a curvature of the penis toward the injured side as the result of the cicatricial tissue formed at the seat of the rupture, which not only interferes with the circulation in the erectile tissue beyond, but makes the organ rigid and inelastic at that point. These evil consequences are apt to be permanent, although as time goes on the cicatrix tends to soften and to be absorbed, so that the condition generally improves to some extent.

A severe blow received directly upon the penis when in the flaccid state has been known, especially in young boys, to tear some of the subcutaneous cellular tissue at its root, and even the attachment between the glans and foreskin, so as to allow the organ to slip out of its sheath and to become incarcerated in the subcutaneous tissues of the abdomen, scrotum, or thigh. This accident is known as dislocation of the penis. The condition is generally accompanied by difficult urination, the urine being forced to follow the strongly curved urethra, or, if the coronal attachment has given way, to follow a long and narrow channel through the tissues in order to escape. Coition is impossible even when the power of erection is preserved. When the case is seen early, the penis can generally be restored to its proper place by manipulation, but when the accident occurs in the ignorant or careless the organ may be left so long in its new situation as to form adhesions from which it is not always easy to free it, even with open incisions. Another difficulty arises in these neglected cases from the shrinking which the sheath has undergone, necessitating some plastic operation to provide the penis with a covering.

Birkett quotes a curious case in which the corpus spongiosum was divided by a horse's bite one inch behind the glans, and the anterior end was turned out through the meatus. The urine was voided by the side of this protruding portion, and nineteen years after the accident it was still projecting from the meatus as a soft pink cylindrical appendage over an inch in length, which seemed to occasion no discomfort.

A common result of a horse's bite, and also of certain accidents in which the clothing is caught in machinery and torn off, is the stripping off of the skin of the genitals with the garments, sparing the organs themselves. The scrotum, as a rule, is easily replaced spontaneously by traction upon the surrounding skin as the wound begins to heal, and by the growth of epidermis over the granulations. But it is difficult to secure a covering for the penis. The best results have followed flaps taken from the abdomen, the usual method being the formation of a bridge-like flap marked out by two horizontal incisions, one near the root of the penis, the other parallel with the first at a distance above it equal to the length of the organ. The skin and subcutaneous tissues are separated from the deep fascia, and the broad strip between the two incisions is lifted up and the penis slipped under it and secured in place by a few stitches. A catheter should be introduced through a perineal boutonnière to avoid the danger of urinary infection of the wounds. After the lapse of a week one of the pedicles is severed and the skin folded under and sutured to the dorsum of the penis. A week later the other pedicle is severed, its edge united to that first sutured to the dorsum, and the organ is thus provided with a covering. The raw surface on the abdomen may be grafted with skin at the same time. The difficulties in the way of the operation are the changes in size which the penis undergoes from the occurrence of erections and the liability of urinary infection of the wound in spite of the perineal drainage. The erections can be moderated by the use of bromide and camphor in large doses, assisted perhaps with morphine. A similar plastic operation may be necessary after sloughing of the cutaneous coverings of the penis from cellulitis or gangrene.

A very common form of injury to the penis is that produced by constricting it with a string or the introduction of the organ into a tight ring of metal or some similar object. This may be done merely in mischief by some boy or from lustful or morbid mental excitement. The delinquent is usually the patient himself, and motives of shame are apt to make him avoid disclosing his condition for some days, by which time considerable damage has been done. The most extraordinary objects are employed by these individuals, and as an example we may mention the case of a man who introduced his penis in a flaccid state into the opening for the handle in the head of a small sledge-hammer, and was unable to withdraw it because erection took place at once and was followed by edematous swelling. The surgeon was compelled to take the patient to a blacksmith's shop, where the steel hammer-head was with great difficulty broken in pieces and the penis was extricated, fortunately without serious injury. The removal of these objects will require the greatest ingenuity and patience on the part of the surgeon. They are usually of a narrow ring-like shape, and cut deeply into the tissues, often penetrating the urethra before the patient comes to the surgeon. In such cases the constricting body may be completely buried from sight, and free incision will be necessary before the cutting pliers or other instruments can be applied to it. In a case related by Kaufmann a small boy was supposed to be suffering from urethral stricture and fistula, but a closer examination showed that a fine string had been tied around the penis and had divided the urethra, while over the dorsum it had cut through the skin, and the latter had healed over it, leaving only a narrow red scar to show its situation. It is generally best to make a long median dorsal incision through the swollen skin, and to expose the constricting body thoroughly as it crosses the bottom of the wound before it is divided. Metal rings are best divided by strong cutting pliers, and if very thick and hard the large "snips" used by tinners will be found useful, for they are very powerful and will cut the metal with the least danger to the surrounding parts. The gangrene which follows the application of such rings is usually limited to the tissues directly beneath them, for they are seldom so tight as to cause complete obstruction of the circulation beyond; but the slough often involves the floor of the urethra and causes extensive urethral fistulæ.

All of these injuries, as well as the sloughing of venereal ulcers or the results of cellulitis, may leave behind them great cicatricial deformity of the penis in the shape of torsion or curvature. The torsion may be so severe as to give the head of the penis a complete half turn on its long axis, the frenum then presenting on the upper surface. The curvature may be so great in any direction as to entirely prevent coition, or at least to compel the individual to assume some unusual position for its accomplishment. Occasionally the cicatrices can be softened and stretched out in time by persistent massage, or the condition can be improved by plastic operations of some kind, such as the excision of cutaneous scars or the division of tense bands by properly placed incisions, followed by grafting or flap-transplantation of skin. But the majority of these conditions will remain permanent in spite of our best efforts, and it is fortunate that really great disability from such causes is comparatively rare.

GANGRENE.

In addition to the common cases in which more or less sloughing of the penis follows as the result of injury or of inflammation, there is a considerable number of instances in which it is produced by some more or less distant cause. In such cases the gangrene affects the distal part of the organ first, and is apt to be extensive, although it is sometimes limited to the prepuce and glans. Apart from a few cases in which it has been the result of obstruction of the iliac veins, the causes are generally constitutional, and most commonly gangrene occurs in one of the infectious fevers in which the patient's vitality has been greatly reduced, the death of the parts being a natural consequence of the poor circulation, which affects the penis as rapidly as the ends of the extremities. It has been observed even in children as a result of one of the exanthemata, although not so commonly as noma of the genitals in little girls. While most commonly seen in typhoid fever, it has also occurred in severe forms of malarial fevers. Atheroma of the vessels undoubtedly predisposes to gangrene, but cases in which that condition has seemed to be the efficient cause are very rare.

The gangrene is usually of the moist form, although isolated cases of dry gangrene have been reported, the constant exposure of the parts to infection undoubtedly explaining the rarity of the latter. When it is observed that the circulation of the genitals is very poor in any case where gangrene is to be feared, it is possible that something can be done to avoid this accident by elevating the parts on a towel or handful of cotton placed between the thighs, and, indeed, this precaution should always be taken in unconscious patients who lie absolutely still and in whom the circulation is much reduced, for it will frequently be observed in them that the flaccid genitals hang down between the thighs, and may even be subject to considerable compression by the limbs, so that the return circulation is much impeded. When gangrene has once set in, all that can be done is to keep the parts as dry and as free from infection as possible. Perineal drainage should be made, if the anterior urethra is involved, to prevent contact of the urine with the sloughing tissues.

INFLAMMATORY CONDITIONS.

Posthitis and Balanitis.—*Posthitis* is an inflammation of the foreskin, the term being usually limited to inflammatory affections of the lining membrane. *Balanitis* is an inflammation of the mucous membrane covering the glans. The two surfaces are generally attacked simultaneously, except in chronic processes which are limited to small areas. The predisposing cause to inflammation of these parts is the difficulty or impossibility of cleansing them, especially when the foreskin is long and narrow. The active cause may be the retained pus of a gonorrhea or venereal ulcer, or merely the accumulated smegma mixed with urine, and perhaps some vaginal discharges added to it in coitus. Balanitis also occurs in diabetic patients, it is supposed on account of the ready decomposition of their sugar-laden urine, a certain fungus being found in the smegma in all diabetic cases, but it is not a common complication of that disease.

In the simpler form of balano-posthitis the glans and the inner layer of the prepuce are red and moist, and a serous pus oozes from under the foreskin or covers the surfaces with white flakes. When the inflammation is more intense superficial erosions and ulcers are seen, especially in the region near the corona. Sometimes thickened patches of the mucous membrane can be felt through the skin of the prepuce, and may even simulate the induration of a chancre. In very severe cases partial gangrene of the foreskin has been observed in posthitis, being caused by the intensity of the local inflammation, and the glans has been found protruding from lateral or dorsal openings in the foreskin thus formed. Croupous and diphtheritic forms of inflammation have been observed also in these parts, the surfaces being covered with a membranous coating, but both of these varieties of inflammation are very rare. If venereal ulcers coexist with the balano-posthitis, they will present their usual appearances, and in cases of phimosis it is often very difficult to ascertain whether there is a simple balano-posthitis or one complicated with venereal ulcers or gonorrhea.

The **treatment** of balano-posthitis consists chiefly in the establishment of cleanliness, and, if the prepuce can be retracted, this will usually suffice to cure. The parts should be washed with warm water or mild solutions of boric acid (gr. v–f℥j), alum or sulphate of zinc (gr. ij–f℥j), or nitrate of silver (gr. j–f℥j). There is no advantage in employing carbolic acid or corrosive sublimate in weak solutions, and solutions strong enough to have any real germicidal effect would be irritating to the inflamed surfaces. It is best to keep the parts as dry as possible, and after using any application they should be carefully dried without rubbing, and small pieces of gauze the size of a postage-stamp should be laid upon the glans and the foreskin gently drawn forward over them. As the modern surgical gauze is so thin, it will be best to have two or three thicknesses between the glans and foreskin, but gauze is better than absorbent cotton, for the latter does not drain so well. A loose handful of gauze is then folded about the end of the penis and the latter placed inside of a pair of swimming tights which the patient should be directed to wear, for bandages are worse than useless on the penis, either falling off or constricting the parts, and the various bags which have been recommended are apt to be uncleanly from being kept in use too long. The tights not only keep the dressing in place, but support the organ in an elevated position, which improves its circulation. The gauze under the foreskin should be changed as soon as it becomes moist, but the parts should not be washed more than two or three times a day. The patient can easily carry a quantity of the small pieces of gauze with him, and any closet will give him the opportunity to make the change. If the case does not improve in a few days under this simple treatment, some powder, such as calomel, bismuth, or aristol, may be rubbed into the gauze or sprinkled over the glans.

When phimosis exists the management of these cases is much more difficult, for the parts must be cleansed by injections. These should be made carefully and repeated several times a day, warm water or some of the solutions mentioned above being employed and thrown in by a syringe with a long narrow nozzle. If possible, drainage should be assisted by the introduction of a little gauze tent inserted under the foreskin, but this must not be large enough to block the orifice. If the discharge continues very foul, it will be necessary to use more active measures, and a 1 per cent. solution of carbolic acid or a 1 : 2000 solution of corrosive sublimate should be employed two or three times, returning to the weaker injections for continuous use. The chief difficulty of these cases will often be the uncertainty as to the coexistence of venereal ulcers or urethritis. If these should be present, and even if they are not, in any case which does not yield to treatment in a few days the foreskin should be split open by the dorsal incision and the parts thoroughly treated. Often a simple case which has resisted injections obstinately will be cured almost at once when the glans is thoroughly exposed. Even if the disease is cured by the injections, the patient should be most emphatically advised to submit to circumcision at once, in order to guard against a recurrence, for the organ which has once been subject to this inflammation will be liable to subsequent attacks on the slightest provocation, and sometimes without any perceptible cause. Circumcision is the only reliable method of preventing these recurrent attacks. When the patient has diabetes, however, any operation must be undertaken with caution, and it should be limited to dorsal incision of the prepuce, owing to the well-known bad effect of that condition upon the healing of wounds.

Occasionally the dry treatment suggested above will be found useless, and the patient will be more comfortable and the inflammation subside more rapidly under a dressing wet with some of the solutions mentioned or with $\frac{1}{2}$ per cent. solution of acetate of aluminum or with balsam of Peru. If these also fail, recourse may be had to the ointments (boric-acid vaseline 10 per cent., or zinc oxide and boric acid in equal parts—5 per cent. of each); but these applications are much less cleanly, and, as a rule, less effective. In very obstinate cases irritant or even caustic local applications may be necessary, and a 2 per cent. solution of nitrate of silver or Churchill's tincture of iodine will be found most satisfactory.

In gouty and syphilitic subjects a dry red patch with a very scanty, thin discharge will sometimes be found, resembling chronic eczema of the skin or even psoriasis, rather than balanitis, and, like these affections, being exceedingly obstinate to treatment. Local applications of nitrate of silver, iodine, or other strong irritant may be tried besides constitutional remedies.

Herpes Progenitalis.—While herpes zoster or zona is found on the penis as well as elsewhere in the distribution of the nerves of the lumbar plexus, it is a rare disease, and does not materially differ from the same affection on other parts of the body. Herpes progenitalis, however, is very frequent, and closely resembles the herpetic vesicles seen so commonly about the mouth in indigestion. A patient will complain of a constant itching about the glans and foreskin, accompanied with a little moisture. When the parts are inspected in the early stages small pinhead vesicles will be seen at the edge of the foreskin, in the neighborhood of the corona, or near the meatus. When the vesicles have broken they leave superficial erosions surrounded by minute circular or crescentic areolæ. The causes of this disease are unknown, but it is certainly more common in individuals with long, narrow foreskins who are somewhat careless about cleanliness of the genitals, and, like the similar affection of the lips, it also appears to be somewhat dependent upon the general health. The eruption is of little significance in itself, as it has no symptoms except the local itching and burning sensations, but it is dangerous, because the erosions which it causes frequently form the grafting spot of a venereal ulcer. Herpes can generally be cured by the dry treatment described above for balanitis, but is very apt to recur, and sometimes no treatment is effectual against these recurrences. Circumcision will generally prevent them, but even after that operation the vesicles will sometimes continue to appear behind the corona. The internal administration of arsenic has been warmly recommended in these obstinate relapsing cases, but this treatment has also often failed.

Cellulitis; Erysipelas.—The tissues of the penis are liable to the same inflammatory processes which are seen in similar tissues elsewhere. One peculiarity about them, however, is the loose character of the subcutaneous cellular tissue, rendering it very liable to intense edematous swelling, and also to gangrene either of the connective tissue itself or of the overlying skin, because of the unsupported condition of the vessels in this tissue. Another important consideration is the frequency with which inflammations of the penis are found associated with urinary infiltration, and the consequent aggravation of their intensity and septic qualities. Cellulitis and erysipelas present their usual characteristics in other respects. Cellulitis most frequently has its origin in some venereal inflammation or in extravasation of urine. Erysipelas is rare. Both are to be treated on the same principles as elsewhere, but when tension exists incisions must be made very early in order to avoid sloughing. Lymphangitis and phlebitis are not at all uncommon, especially the former, and generally originate from some venereal ulcer or a gonorrhea. Sometimes they are confined to a single vessel, and at others they are more or less general. If only one vessel is involved, it can be felt as a hardened cord under the skin, and frequently there will be a red line on the surface above it. This inflammation generally resolves, but sometimes abscesses are formed and must be promptly opened. The phlebitis is almost invariably confined to the superficial vessels, and does not spread to the cavernous tissue. A chronic lymphangitis sometimes persists, and results in a permanent enlargement caused by a chronic edema or hypertrophy of the cellular tissue of the parts resembling elephantiasis. True elephantiasis of the penis is very rarely seen in this country.

Cavernitis.—A suppurative inflammation is not infrequently found limited to the cavernous tissues in some one or all of the cavernous bodies, and has been given the name of cavernitis. When the inflammation is general it is sometimes spoken of as a "penitis," but this term is inaccurate and should not be employed. It is generally caused by a folliculitis or a small extravasation of urine, and may be limited to one point or may involve the entire corpus spongiosum or the corpus cavernosum of one side or even all three of these organs. The result is a sloughing or breaking down of all the erectile tissue within their capsules, leaving only the latter, and after recovery the part is represented simply by a small fibrous, cicatricial mass. It is generally indicated at its onset by edema of the prepuce and a painless priapism and induration of the part involved. Pyemia is a frequent but not invariable sequel, for it can be avoided by early incision. Free incision into the fibrous capsule of the affected portion of the organ is the only possible treatment, and must be carried out as soon as the diagnosis can be made. Recovery takes place with a permanent loss of function of the affected side.

There are certain chronic inflammatory conditions of the corpora cavernosa which are of interest. In gouty and diabetic individuals nodules of a fibrous character form in the erectile tissues, or more frequently in their capsules, being produced by a chronic inflammation or cavernitis. They sometimes develop rather acutely, and there is then considerable inflammatory swelling around them, which disappears afterward, leaving the masses smaller, but they are permanent when once formed and no treatment is of any avail. They usually form flat plaques on the surface of the corpora cavernosa, on the sides or dorsum near the root. Fortunately, they are of no consequence unless they interfere with erection by causing curvature or loss of stiffness, just as deep cicatrices have these effects, but as they occur late in life, even this result is not of great importance. General treatment should be instituted to prevent the formation of larger deposits. The gouty nodules sometimes become calcareous, and occasionally sheets of true bone are found in the fibrous coverings of the erectile tissues, resembling those bony plates which sometimes form in muscular tissue after repeated mechanical irritation.

TUBERCULOSIS.

Tuberculosis of the penis is rare, but occurs in two forms. The majority of the cases are examples of chronic tuberculous ulceration of the skin or mucous membrane resembling that seen elsewhere, the ulcers having the same irregular worm-eaten shape, the same blue undermined edges, and the same slowly sloughing or poorly granulating base. The other form, which is very rare, appears to begin in the depth of the erectile tissue, producing a necrotic mass closely resembling the tuberculous sequestra seen in spongy bone, the wedge-like shape of the latter, it will be remembered, suggesting an origin from a tuberculous embolus having been lodged in one of the vessels. A section through this focus in a case of this kind reported by Kraske showed a rather firm yellowish-white mass of necrotic tuberculous tissue in the midst of the erectile tissue of the glans, sharply limited from the healthy tissues about it, which had penetrated by extension of the sloughing process through the mucous membrane of the dorsum, producing a circular ulcer with ragged, thin, undermined edges, and a base consisting of the surface of this tuberculous mass. The diagnosis from a gumma would not be very easy in cases of this kind.

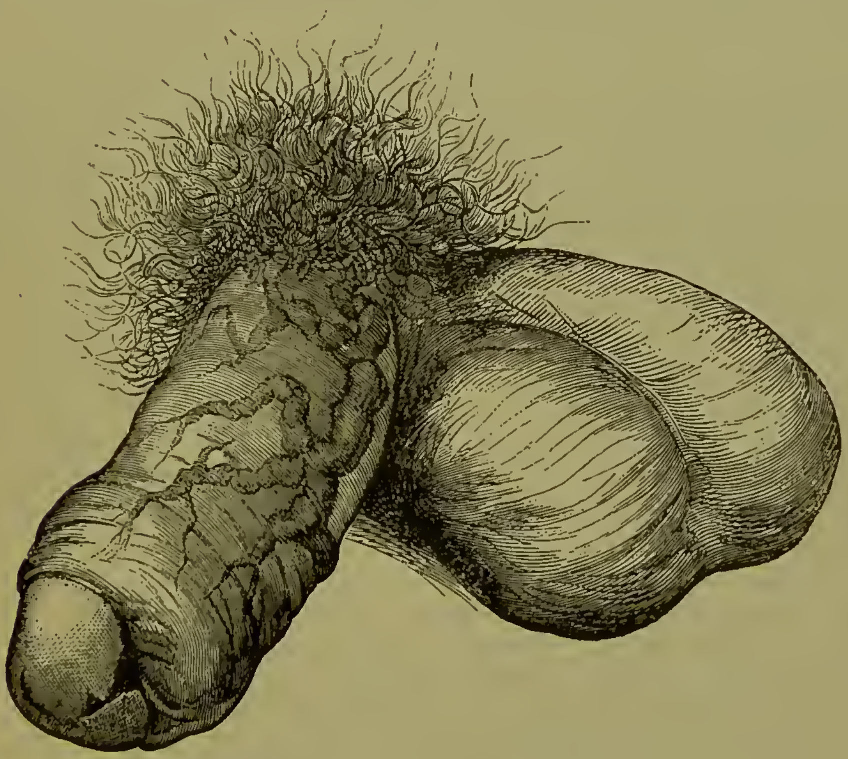

FIG. 37.—Varicose veins of penis (Demarquay).

VARICOSE VEINS.

Varicose veins are frequently found upon the penis (Fig. 37), and as a rule they are of little pathological significance, although occasionally they may be accompanied by a loss of power in the erection. At all events, failure of erection has been successfully treated by ligature of the dorsal vein or other branches, even when the varicosity of the vessel did not appear very marked. It is difficult to appreciate the real value of this procedure, because the individuals affected are apt to be neurasthenic and easily impressed, so that the mere psychical effect of the operation might suffice to remove their disability, but in two cases the writer has obtained such an improvement that he considers the method of treatment valuable, and certainly it is without danger.

NEURALGIA.

The penis is occasionally the seat of neuralgia, which may be intensely painful. The pain is usually reflex and caused by some vesical or pelvic disease, but in some cases no cause can be found, and we assume that it is due to a neuritis of the pudic nerve. The pain is generally most intense at the head of the penis. If some such cause as suggested can be found, its removal will cure the condition, and a careful search should be made for it. If it cannot be found, reliance must be placed in medical treatment carried out on the usual lines. Gouty symptoms should be sought for, and the treatment directed to that condition in doubtful cases.

PRIAPISM.

Priapism is a condition of continual erection without sexual desire. It occurs as the result of various local disturbances, such as inflammatory swelling of the penis, hematoma, or tumors. It is more commonly, however, the result of reflex nervous irritation caused by phimosis, vesical calculus, or some urethral lesion. It is also found as a symptom of injury or disease of certain parts of the spinal cord, especially in the cervical and upper dorsal regions. In some unexplained way it may also be caused by leukemia and gout. Excessive sexual excitement and indulgence, probably acting on the spinal sexual centers, would appear to be the main factor in its causation in some cases. In all of these instances priapism may be considered as a mechanical result or as a symptom of some other condition, but occasionally it is observed without any perceptible cause, and therefore it requires to be described among the diseases of the penis. In these inexplicable cases the erection comes without warning, although it sometimes follows a natural erection with sexual desire, and persists in more or less complete degree for a great length of time, usually three to six weeks, sometimes as many months. The erection is often painful, and the patient dreads the touch of the bedclothes, but even when not painful its long continuance is exceedingly trying. Sexual intercourse merely increases the distress. Micturition may be difficult, owing to the swelling of the parts. No treatment is of much use, and sedatives (bromides, morphine), with the occasional administration of a purge, is all that can be done medically, besides the local application of ice or very hot cloths and protection from pressure. In some cases incisions into the corpora cavernosa have been of benefit, and this method of treatment is worthy of further trial. Recovery is sometimes followed by a permanent loss of erection, and this occurs both in cases treated expectantly and in those operated upon, while some cases operated upon have recovered without this loss, so that it is as yet uncertain whether incision increases the danger of the occurrence of this disability.

TUMORS.

With the exception of the papillomata which are so common as the result of venereal infection or lack of cleanliness, new growths of the penis, especially the benign growths, are unusual. Although cancer of the penis is the commonest of its tumors, the penis ranks seventh in the order of frequency of the various organs liable to that disease in the male, and its malignant tumors form only from 1 to 3 per cent. of all cancers of both sexes.

The **chondromata** and **osteomata** of the penis which have been occasionally reported are rather to be classified as cases of ossification of the fibrous structures of the penis than as true tumors. Tuffier, however, has recently reported a small chondroma which grew on the external surface of one of the corpora cavernosa, near the middle of the organ, and was removed by operation when it had reached the size of a small bean. A few instances of *fibroma* and *lipoma* have also been placed on record.

Angioma is rather more frequent than the other benign tumors, although it does not attack the penis so commonly as the female organs of generation. It is usually connected with the blood-vessels, although lymphangioma is not unknown—without including under that name true elephantiasis or other forms of lymphatic enlargement. As it is found in the penis, angioma generally occurs in infants, and forms a superficial flat tumor, which rarely gives rise to any symptoms, although troublesome priapism has been observed when it involved a considerable part of the organ. More than one tumor is sometimes found. Angiomata present the usual varieties seen elsewhere—some a mere dilatation of the superficial capillaries of the skin, others involving the entire thickness of the latter and containing large vessels.

The **prognosis** is the same as in similar tumors elsewhere, many remaining stationary, a few disappearing spontaneously or being cured by ulceration, and others continuing to grow to a dangerous extent. The risks of the condition from extensive growth, hemorrhage, and septic infection are sufficiently great to demand immediate treatment, especially as the latter is without danger. This treatment should be similar to that employed for angioma in other situations—electrolysis, cauterization, or excision. When not too extensive, removal by the knife will be found to be the readiest and surest method, for the hemorrhage is slight if care is taken to make the circumscribing incision in the healthy skin just beyond the dilated vessels, and the superficial wound which results can readily be closed by sutures. But if the angioma involves much of the skin of the organ, and it is feared that there will not be enough material to allow of excision, multiple puncture with the sharp point of the thermo-cautery or the galvano-cautery (an anesthetic having been administered) will generally prove satisfactory, although several sittings may be necessary. The minute wounds heal under a scab or by granulation. Electrolysis is less certain and very tedious, for it requires many applications, which protract the treatment over several months, even if applications are made every week. The various methods of treatment of angioma by ligature or the introduction of threads soaked in perchloride-of-iron solution should not be used for angioma of the penis, because of the difficulty of keeping the parts clean and the consequent danger of septic infection.

Primary sarcoma of the penis is a very rare affection, although in the few cases reported the round-cell, the spindle-cell, the melanotic, and the angiomatous forms have all been represented. Like sarcoma in other parts of the body, it may be found at any time of life from childhood to old age. It has been observed only in the connective tissue of the erectile portions of the organ, running a rapid and insidious course, and probably for this reason generally returning after extirpation, having already reached a development at the time of operation which gave no hope of cure. Secondary sarcoma is found rather more frequently, but is nevertheless a rare occurrence.

Sebaceous and **dermoid cysts** have occasionally been observed. The dermoid cysts are very small, develop along the raphé, and are very rare tumors. Sebaceous cysts, however, are quite common, and may originate from the modified sebaceous glands (Tyson's glands) behind the corona, as well as from those of the skin, so that they are found in all parts of the organ. They are sometimes multiple, and are in that case small, but the single cysts not infrequently attain the size of a hen's egg, forming a serious obstacle to coition, especially when they are situated in the prepuce, which is their usual location. Solid tumors have also been known to grow from the modified sebaceous glands, forming adenomata. All of these benign tumors should be removed by operation, the sac of the cysts being carefully dissected out in order to prevent a return. The very numerous small cysts, however, may be simply incised, and their lining destroyed by thorough cauterization.

Papillomata are to be found anywhere on the skin or mucous membranes, but are most common on the inner side of the foreskin near its reflection upon the glans. They occasionally attain great size (Fig. 38), and have been known to perforate the foreskin in cases of phimosis by their outward pressure—a condition which might lead to the mistake of supposing them to be infiltrating malignant growths unless a careful examination was made. Under the general name of papilloma we include the so-called venereal wart, as it differs in nothing from the ordinary forms, and its only connection with venereal diseases is the fact that the latter are apt to cause irritant discharges, which are a well-recognized cause of the growth of warts in general. Any irritant discharge or secretion, especially if covered and protected from the air by a long foreskin, will cause the growth of papillomata, and this fact explains their frequent appearance behind the corona. There are some instances on record of contagion of these warts from one sex to the other, but probably this is merely due to a transfer of the irritating material, with a similarity in habits of neglect and lack of cleanliness, as there is nothing specifically contagious in their secretions, foul as they often are.

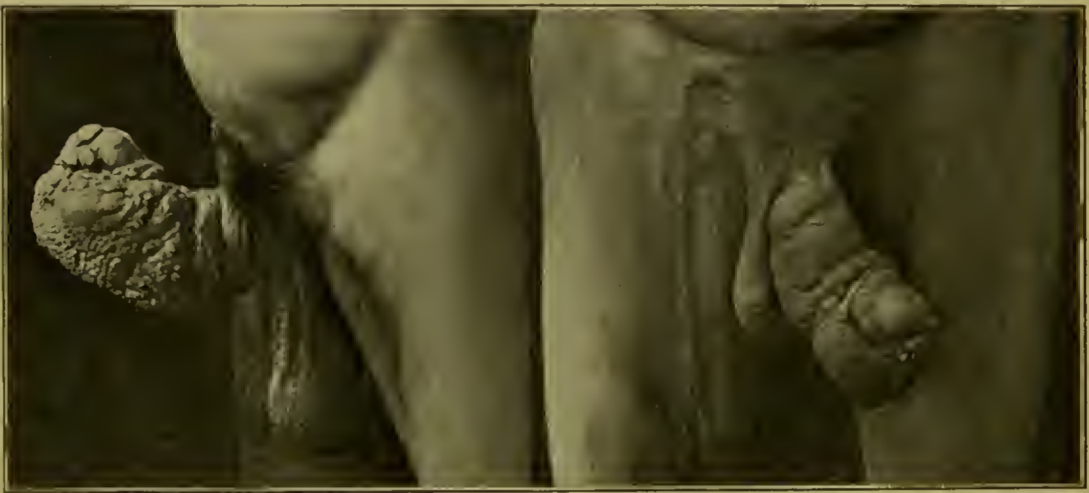

FIG. 38.—Papillomatous hypertrophy of the penis (case of Dr. R. Abbe).

The papillomata may be single or multiple. When protected from the air they are moist, soft, and pink, but if exposed they become dry, hard, and brown in color. In the latter case they sometimes give rise to the curious appendages called horns, resembling those found on the skin elsewhere. The horn sometimes forms a flat plate, but far more often a projecting appendage (Fig. 39), which may attain a length of three inches. These horns

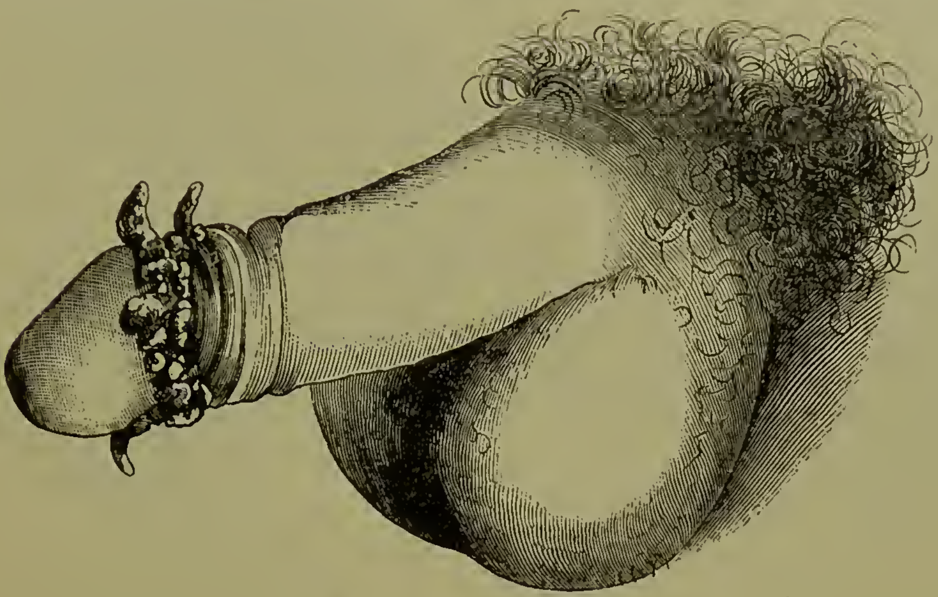

FIG. 39.—Horn of penis (Demarquay).

are usually more or less curved if long, and of a dark-brown or green color, in texture resembling the nails, but rough on the surface. They generally arise from the coronal sulcus, especially near the frenum, and on removal a wart will be found at their bases. They are found in persons of careless habits, and, although more frequent in advanced life, they have been seen at the age of nineteen years. They are so rare as to be little more than surgical curiosities, but are worthy of mention because they are occasionally the cause of an epitheliomatous growth around their bases.

The ordinary papilloma may sometimes become converted into an epithelioma after retaining its original benign character for years, and it should also be noted that epithelioma, and even sarcoma, may resemble ordinary warts in their early stages. A positive diagnosis will be impossible in some cases, and every wart which does not yield promptly to treatment or which obstinately returns after removal should be regarded with suspicion, especially if the patient is over thirty years of age. The tumor should be examined microscopically before further treatment, or else it should be dealt with at once as if it were malignant.

Every case of papilloma, in fact, demands thorough treatment, for even the simplest forms are marked by their tendency to return after removal unless the original cause is abolished and the tumor eradicated in the most thorough manner. The first steps in the treatment must be the cure of any balanitis or venereal discharge or ulcer, the reform of the patient's hygienic habits, and the institution of perfect cleanliness, and, in addition, the performance of circumcision if there is phimosis or an unduly long foreskin. The little tumors themselves can be destroyed with caustics, such as alum, salicylic acid, ferric chloride, glacial acetic acid, or fuming nitric acid. The last-mentioned acids are generally preferred, being applied with a little splinter of wood to the growth after the surrounding surfaces have been carefully protected with some grease, such as vaseline. After the wart has sloughed the base should be cauterized again, as it is seldom that the first application will destroy the roots of the diseased papillæ. The hot iron may be employed for cauterization instead of chemicals. Some recommend the ligature of such papillomata as have slender pedicles, and perhaps this procedure might be permitted with very timid patients or where the tumor is so near the meatus that there seems danger of the production of a contracting scar by the caustic, but the pain is quite as severe as removal with the scissors, and the base must be cauterized afterward to prevent recurrence. For growths of any size removal with the scissors or sharp curette is to be recommended, cutting away not only the growth, but a portion of the tissues upon which it is seated. This little operation can be done painlessly with the help of cocaine applied to the surface or injected at the base of the wart, and the hemorrhage can always be controlled by pressure and styptics, although in some cases it has proved very obstinate and required the cautery. After the removal of the growths by caustic or excision the parts should be kept as dry as possible by some of the methods suggested in the treatment of balanitis.

Cancer of the penis is almost entirely a disease of advanced life, the sufferers generally being over fifty, and it is very rare before the thirtieth year. Weir has reported one at eighteen years of age. It occurs almost exclusively in the form of epithelioma, or that variety of carcinoma which consists of flat epithelial cells, although isolated instances of true carcinoma, and even melanotic carcinoma, of the penis have been reported, and it corresponds in etiology and prognosis with the epitheliomata of the skin observed elsewhere in the body. Secondary carcinoma is unusual, but sometimes follows a primary tumor in the testicle, scrotum, rectum, or other pelvic organs, seldom in any other part.

Etiology.—Its most frequent cause appears to be the chronic irritation set up by dirt or foul secretions, especially when retained under a long foreskin; but while some observers have found phimosis present in three-quarters of the cases which they collected, others deny that the combination is present in more than one-tenth. The disease certainly appears to be less common in circumcised individuals than in those with a natural prepuce. Many efforts have been made to bring syphilis and other venereal diseases into causal relation with cancer, but these diseases appear to be active only in so far as they give rise to inflammation, acrid discharges, chronic ulcers, and masses of induration, which may furnish the necessary irritation which seems to cause the epitheliomatous proliferation. A sufficient indication of the rarity of syphilis in the early stages acting as a cause of cancer is furnished by the statement of Taylor, that he has seen but one case of cancer developing upon the basis of a syphilitic lesion, that having appeared upon the scar of a chronic induration left by a previous chancre. But in the chronic ulcers of late syphilis malignant change is not rare. The writer has observed an epitheliomatous ulcer develop from a tertiary syphilitic ulcer behind the corona in a man only thirty-eight years old, the original ulcer having been under observation for several years, in which time it was repeatedly closed by antisyphilitic treatment, but as often returned, and finally perforated the urethra before the patient would submit to operation. It is true that in this case the ulcer had been subjected to a very vigorous and perhaps injudicious use of caustics (in other hands) when it returned the last time. The organ was removed with the inguinal glands before the latter were infected.

It has often been claimed that this disease might be due to infection from

PLATE I.

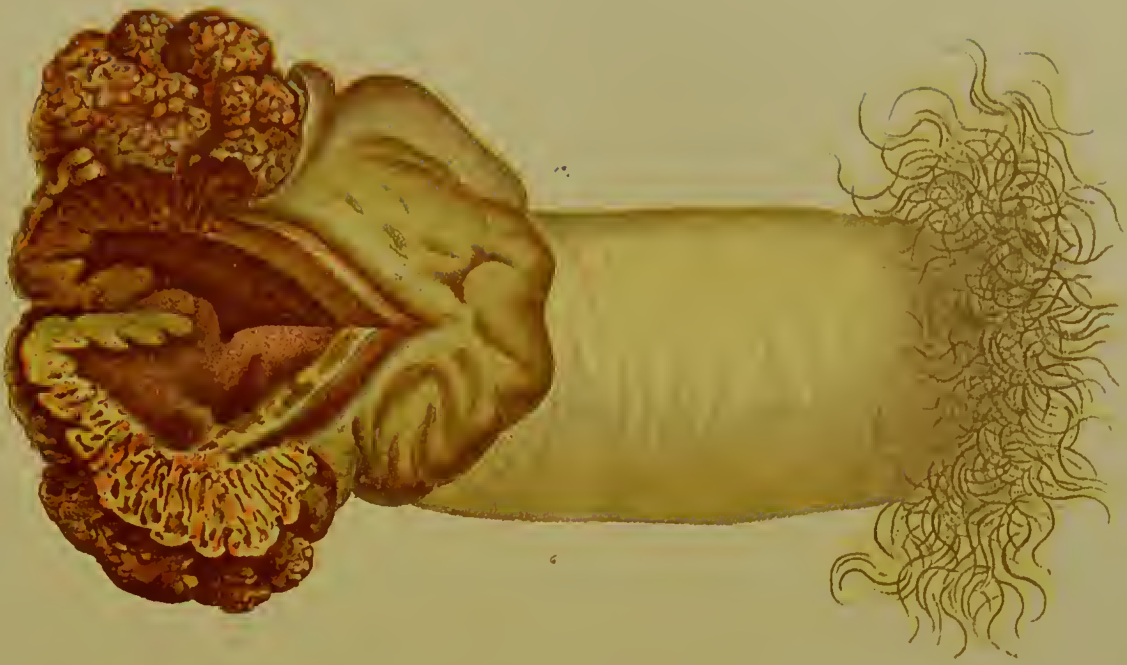

FIG. 1.—Cancer of glans penis: vegetating form (Demarquay).

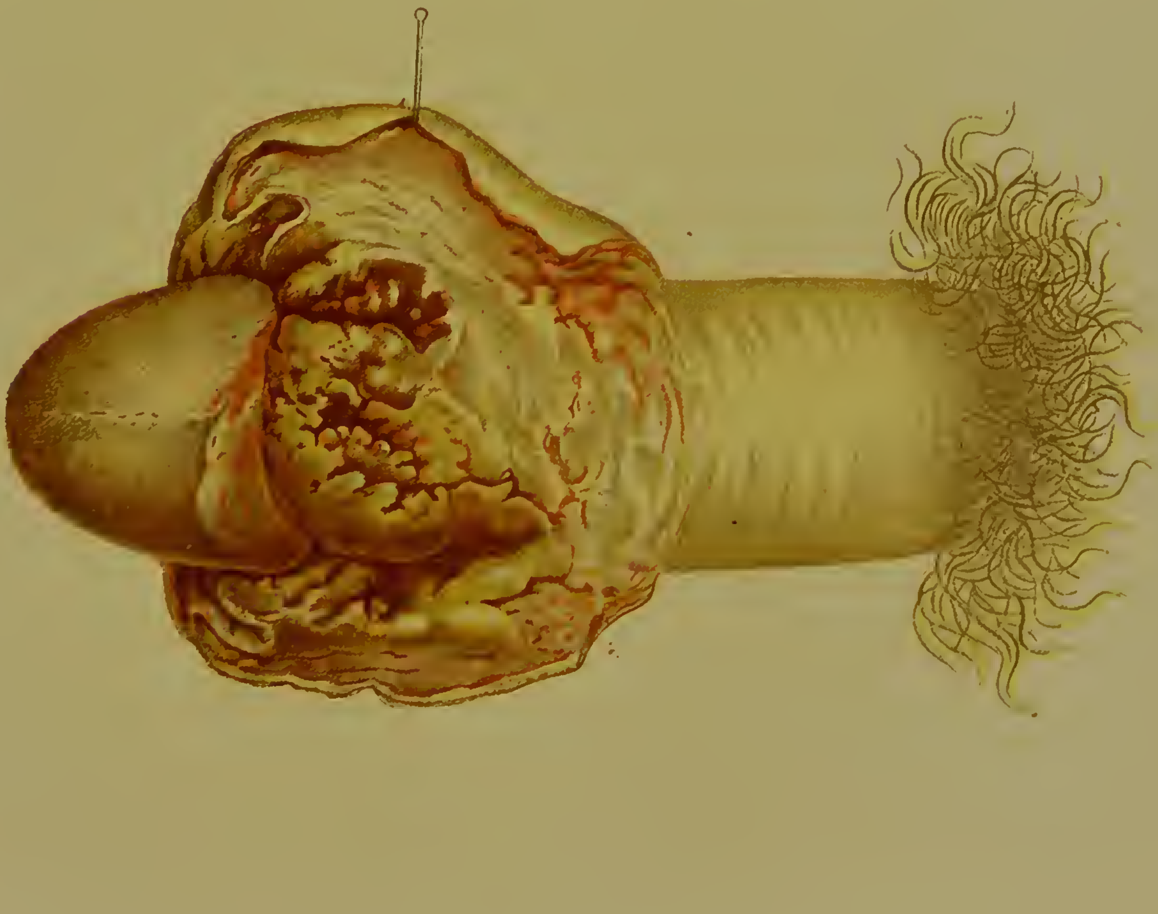

FIG. 2.—Cancer of the prepuce and body of the penis (Demarquay).

the cancerous uterus, but the immense number of cases of cancer of the uterus, in many of which coition has been continued long after ulceration has taken place, is in striking contrast to the rarity of the corresponding disease in the penis. In spite of the careful search which has been made by investigators all over the world for more than a century, there are not more than two or three authentic cases on record of the simultaneous occurrence of cancer of the uterus and penis in a married couple, and this small number indicates that their combination was probably a simple coincidence. This supposition, therefore, is absolutely without foundation in facts. Another favorite hypothesis in the etiology of cancer is the influence of heredity, but it has even less basis in the case of cancer affecting the penis than in the same disease elsewhere, for only two or three cases are known in which cancer existed in the parents of an individual afflicted with cancer of the penis. As in the case of malignant disease in the other organs, there are not wanting a few instances of cancer of the penis in which a traumatism was apparently the cause of the new-growth, but the number is too small to serve as the foundation for any theory.

Clinical History.—Epithelioma of the penis may arise from a wart, either single or multiple, and it may also resemble a wart in its earliest stages. In other cases it develops from a simple or venereal ulcer, especially a chronic ulcer of syphilitic origin, or even from a superficial excoriation such as is common in balanitis. If a wart becomes indurated and brittle, the base growing hard, and the induration tends to invade the surrounding skin, it has probably undergone malignant change. In the same way a marked induration and a tendency to spread or a readiness to bleed at the slightest touch should make one suspect any chronic ulcer or patch of excoriation, especially in elderly men. In some cases thickened patches slowly develop in the epithelial covering of the glans, resembling the condition known as leukoplakia in the tongue, producing whitish spots which crack and easily become excoriated, and these patches, like the similar disease in the tongue, are very liable to malignant transformation. In still other cases the malignant disease seems to begin below the surface, probably in some of the sebaceous glands of the skin, forming a small hard lump covered in its early stages by unaltered epithelium. We need only mention the fact that epithelioma of the scrotum or other parts may spread over and involve the penis by extension of its growth.

Cancer almost invariably originates from the glans or foreskin. On account of its insidious beginning, and owing to delay from carelessness, ignorance, and false modesty, it is generally allowed to grow for many months and to spread to a considerable extent before it is brought to the surgeon's attention. At this time, when it is fully developed, it usually appears in one of two distinct forms. The commoner of these types is papillomatous, in shape like a cauliflower, being smaller at the base than above, with deep clefts between the warty protrusions which form its mass, these warty protrusions being sometimes numerous, small, and slender, sometimes more scanty, but large and fleshy. The tumor may attain a large size, forming an immense knob on the end of the penis, sometimes measuring nine inches or more in circumference. While it is small the mass may be covered in whole or in part by the foreskin, but the latter is gradually pushed back or sloughs, and the growth is exposed. The surface of the tumor may be moist and of a bright-red color, or it may be more or less covered with white or gray sloughs. The small tumors, however, may be very dry and the surface a dirty gray or brown.

In the other and rarer variety, destruction of tissue is marked as well as growth, and the tumor consists of an ulcer which may be very deep in the center, with greatly thickened and indurated borders, the induration preceding the spread of the ulcer on all sides. The base of the ulcer is irregular, sloughing, and not infrequently perforates the urethra so that the urine finds its way out through the soft and sloughing tissues as well as through the meatus. The ulceration may progress until nearly the entire organ has been destroyed, but in spite of these extensive changes it is only in rare instances that any real obstruction to the escape of urine is found. In the last stages the two forms described may present a similar appearance, for extensive sloughing may take place in the large fleshy tumors also, resulting not only in reduction of their size, but in destruction of the penis itself.

Either form may develop under a narrow foreskin, and the extent of the destruction cannot be realized until the prepuce is laid open, when the glans will sometimes be found to have disappeared entirely, its place being filled with large fungating masses from the inner side of the prepuce, the only evidence of this extensive disease being a little papillomatous growth at the orifice of the latter and the fetid discharge. For these reasons Kaufmann wisely recommends that in elderly men with phimosis and a foul discharge from under the foreskin, the possibility of cancer should always be borne in mind, even if no characteristic induration can be felt.

Beyond the discomfort of the sloughing and the offensive discharge sometimes found, the tumor does not affect the general health of the patient, and causes comparatively little suffering, although severe hemorrhages have occasionally been observed in the late stages of the disease, and pain is also sometimes severe at that time. But the great danger to the patient lies in the spread of the disease by the infection of the lymphatics. This usually attacks the nearest lymphatic glands, but in at least one recorded case a secondary tumor was produced in the course of the lymphatic vessels along the sides of the organ. We are all familiar with the very early infection of the lymph-nodes in the groins which occurs with venereal ulcers, and this rapid involvement is not surprising when we consider the short distance and direct route which the lymphatic vessels pursue along the dorsum of the organ to these glands. Although the progress of the carcinomatous infection in the same direction is not so speedy, yet it is even more certain, and in some cases undoubtedly takes place very early. In some instances the disease appears to be very slow in reaching the lymph-nodes, as in a case reported by Taylor, in which the penis was amputated without removal of the glands after the tumor had existed for six years, and yet the patient remained well ten years later. On the other hand, other observers have found the glands attacked in every case, although in some the changes were so minute as to be recognized only by the microscope. Jacobson believes that the time of infection depends in part upon the local conditions, and that the glands will be involved early when the tumor is moist, especially if it is protected by the prepuce, and also in cases in which its growth is rapid; while if the tumor is dry and its discharge is not retained about it by the foreskin, or if it spreads slowly in the surrounding tissues, this infection will not occur until later, because under the latter circumstances there will not be so much tendency to absorption of cancerous material. But these considerations appear to be purely theoretical, and we know too little about the real causes of carcinomatous growth to be able to say what conditions would encourage or delay infection of the lymphatics. It is certainly impossible to tell from the condition of a cancerous growth in other situations—in the breast, for example—whether the glands will be found extensively diseased or not, some of the largest, most rapidly growing, and most extensively sloughing tumors apparently involving the glands very late; while other tumors of slow growth and apparently rather benign local characteristics infect the glands from the first.

The lymph-nodes involved in cancer of the penis lie so close to the femoral and saphenous veins that their enlargement causes obstruction of the circulation in these vessels, with edema of the lower extremities, and when ulceration attacks these glands severe hemorrhages from the veins are common occurrences. Sloughing and ulceration of these glands, moreover, is very common, and is undoubtedly due to the fact that they are subject to pyogenic infection as well as to carcinomatous infiltration, owing to the foul condition of the penile growth. This tendency to pyogenic infection readily explains those rare cases in which the glands were enlarged at the time of operation for cancer of the penis, but were left untouched by the surgeon, and yet have disappeared spontaneously afterward.

With the appearance of greatly enlarged glands in the groin the end approaches. The penis has been more or less destroyed or altered into a shapeless mass, the urine escaping from a dozen sinuses in the ulcerating tumor, large sloughing ulcers exist in the groins, and the feet and legs are swollen. The patient is poisoned with septic substances circulating in the blood, pale from repeated hemorrhages, and often suffers continual and sometimes agonizing pain, until he finally succumbs to the disease. The duration of cancer of the penis is variable, for it sometimes runs its course in a few months, and sometimes is prolonged by incomplete operations or even by its own slow progress over many years, but, as a rule, the time elapsing from the first marked symptom to the end in cases left without treatment is about two years. Secondary deposits in other parts of the body are very rare, only three or four such cases being known: the writer has seen extensive secondary deposits in the lung in one case causing death a year after operation without local recurrence. The disease spreads almost entirely by the lymphatics, very seldom invading the cavernous tissues. In some cases, however, it attacks the latter, and microscopic deposits have been found in them even when they appeared healthy to the unassisted eye.

The **diagnosis** of epithelioma in its early stages may present the greatest difficulty. The most reliable symptom is the induration generally found at the base of a wart or on the edges of a suspected ulcer, which tends to spread into the surrounding tissues; but, as Jacobson remarks, this sign is not altogether to be depended upon, for both wart and ulcer may remain free from induration long after the microscope would show the beginning of malignant changes. Fortunately, the microscope can always be made to decide in doubtful cases, for excision is excellent treatment for both wart and suspicious ulcer, so that if the small lesion be removed it can be subjected to examination, and the patient will be cured by the trifling operation even if the suspicion prove without foundation. In fact, it is safer to make a wide removal in both cases if the disease proves obstinate to milder measures, even if the microscope fails to discover proof of malignancy. The diagnosis of cancer from venereal ulcers is usually simple, owing to the well-marked peculiarities of the latter lesions. But the diagnosis between ulcerating gumma and epithelioma is not so easy. The gumma, however, is known by its soft, undermined edges and by the fact that ulceration is the main feature, while in cancer there is always some new growth, and finally by the readiness with which the syphilitic lesion generally yields to treatment.

As has been stated, any case of foul discharge from a narrow foreskin in an elderly man should be considered suspicious, and should be subjected to dorsal incision or circumcision, even if no induration can be felt through the prepuce, in order to settle this important question. Even if only a severe balanitis exists, it is for the best interests of the patient to be freed from a disease which is a constant source of danger, especially at this time of life. Sometimes when the prepuce cannot be retracted the hard swelling of a lymphatic vessel in the sheath of the penis or the induration and enlargement of the inguinal glands will give a clue as to the real nature of the affection. The presence of primary or tertiary syphilis should not long delay the surgeon, for it is quite possible for epithelioma to coexist with syphilis or to develop upon a syphilitic ulcer, and if a fortnight of well-directed treatment with mercury and the iodids does not bring about a marked improvement, the disease should be considered malignant and dealt with accordingly.

The **prognosis** of the disease under any other than operative treatment is hopeless: the tumor must be removed by the knife or by caustics. Nor should the surgeon be satisfied with thoroughly removing the tumor itself, but the glands in the groin should also be removed, even if they give no evidence of disease, for enlargement and induration are the only signs by which the presence of disease in them can be recognized, and the microscopic changes begin long before these symptoms are evident. In 9 cases examined by Gussenbauer after operation, the glands were diseased in all, but in 2 of them the changes were so slight as to be discovered only under the microscope. There is no possibility of this change ever retrograding when it has once begun, and the only safe rule is to extirpate the inguinal glands as well as the original tumor, however small the latter may be, and even if there is no outward sign of glandular disease. Many cases are on record in which the glands have enlarged and proved to be carcinomatous long after the removal of the penis, even without any local recurrence, showing that if the glands had also been extirpated in the first place a complete cure could have been obtained. If the tumor is thoroughly eradicated, the prognosis is one of the best in malignant disease, being as good as in ordinary epithelioma of the skin, and giving a cure in 40 per cent. of the cases. If only favorable cases were considered, the percentage of cures would undoubtedly be much greater, and it can certainly be improved in the future by earlier and more thorough operations.

In all cases except the most trifling the entire organ should be removed down to the pubes, and in bad cases the complete extirpation, including the crura, first systematically carried out by Thiersch, should be performed. In all cases, too, the lymphatic glands in the groin should be removed. As has been already mentioned, both the crura and the glands may contain microscopic changes, although nothing is evident to the naked eye; but, as a matter of fact, at the time of the first examination of the patient by the surgeon the glands will usually present distinct enlargement. The time has not yet come when we can afford to relax our vigilance in the treatment of malignant disease, and our operations should be more radical rather than less so until the results improve.

Caustics should not be employed in the treatment of cancer of the penis, for they are not sufficiently thorough, and in modern times with anesthesia at hand it is needless cruelty to subject patients to the suffering of such extensive cauterization as must be employed to fully eradicate even the smallest malignant tumor of the penis. We must also give warning against the use of *mild* caustics in the treatment of suspicious warts or ulcers. The practice of applying such substances as nitrate of silver to warts, ulcers, and excoriations of all kinds is still too general. Such applications can serve no good purpose, and if there is any beginning malignant tendency they do untold harm, setting up more irritation and hastening the malignant changes. If any lesion upon the penis is suspicious, it should either be completely eradicated by the most powerful acid or by the knife, or else left entirely untouched under some simple indifferent treatment, while the surgeon watches its development in order to determine its true character. There is good reason for believing that the application of such irritants as nitrate of silver can turn the scale in favor of malignancy in some simple wart or ulcer which would have been permanently cured without tendency to return if it had been clipped out with the scissors or completely destroyed by nitric acid.

Amputation of the Penis.—The usual amputation of the penis by the circular or flap method is not a difficult operation. In the former the skin is divided by a circular incision a finger's breadth in front of the pubes and retracted. The dorsal vessels are secured with clamps or ligatures, and then each corpus cavernosum divided in turn close to the pubes, the central vessel being secured by a clamp. The corpus spongiosum is then separated from the cavernosa anterior to the point of division of the latter, and divided half an inch farther forward, so as to assure a proper length to the urethra. Hemorrhage is controlled by ligatures, or, if there is a great deal of oozing from the erectile tissue, the fibrous coat can be sutured over the stumps of the corpora cavernosa. It is better to make the section of these parts slowly as described, taking up the vessels as they are exposed or divided, than to trust to compression by an assistant's fingers or by the rubber ligature, as these aids prevent the surgeon from cutting close to the pubes. In any operation upon the anterior part of the penis, however, it is possible to make the incisions entirely bloodless by transfixing the organ by two large needles or pins placed in X-fashion, so as to clear the urethra, some distance behind the site of the incision, and then winding a narrow rubber cord around the organ two or three times just behind the pins, the latter preventing it from slipping off. But this is not recommended in amputations. After the parts have been cut away the urethra should be slit up for at least half an inch along its floor and secured to the edges of the skin. Whether the latter is united in a vertical or in a horizontal direction is a matter of indifference, but it will be a little easier to adjust the urethra in the former case.

In the flap operation the flaps may be of equal length and cut either laterally or above and below. A favorite method is to cut a single long dorsal flap, dividing the skin below circularly. When the amputation is finished the dorsal flap hangs over the front of the stump like an apron, and a small incision is made in its center, to the edges of which the urethra is secured after being slit up as described. The object in slitting the urethra in this way is to prevent the cicatricial contraction, which would undoubtedly take place if it were allowed to unite by a small circular cicatrix. The opening when the wound heals should resemble the meatus of a slight grade of hypospadias. The old operation of amputation by the galvano-caustic loop is to be rejected as incompatible with asepsis and primary union.

Removal of the Inguinal Glands.—In operating for cancer, as has been said, the glands in the groin should also be removed. This is done by the usual incision along Poupart's ligament. The skin should be dissected up and down, thoroughly exposing the region. When the upper flap has been dissected far enough back to be entirely clear of the glands, the knife is directed toward the abdominal wall, and made to cut inward until the fascia of the external oblique is reached. Beginning at the outer angle of the wound, the whole mass of fat and glands is then dissected from the abdominal wall bluntly or with scissors and knife, in a direction inward and downward, until Poupart's ligament is reached. The same plan is then adopted below, cutting directly toward the fascia when the skin-flap has been dissected up, then beginning again at the outer angle and working inward and upward. Here the dissection must be very carefully conducted, as the saphenous vein should be avoided, and yet it is necessary to dip well down into Scarpa's triangle in order to secure the glands which lie just over the femoral vessels. Finally, the two planes of dissection will meet at Poupart's ligament, and the entire mass of fat, with the glands included, can be removed in one piece. Only in this way can the surgeon be sure that all the small lymph-nodes of the region are extirpated, together with their communicating vessels, for all of these are sources of danger. When the operation is systematically performed it should not require much if any longer time than the desultory picking out of one gland after another which is so often practised. The operation is to be carried out on the same principles as the clearing out of the axilla after an amputation of the breast.

Extirpation of the Penis.—When the disease in the penis is extensive and the ulceration has attacked the erectile tissue, it is necessary to remove the crura as well as the rest of the organ. The operation already described will give good results when the erectile tissue is not compromised, for it removes all of the lymphatics which are likely to be diseased. But if the erectile tissue be involved, the same principle of complete extirpation must be applied to those parts. In performing this extirpation of the penis the author follows the teaching of Thiersch, but prefers to remove the inguinal glands first in a manner similar to that described above, but making the incisions on the two sides meet over the pubes, and leaving the two masses of glands attached to the root of the penis by a pedicle of fat and vessels. The patient is then placed in the lithotomy position, the skin of the penis is divided by a circular incision at its root, and the scrotum is split by a few strokes of the scissors and by blunt dissection, so that the two tunicæ vaginales lie on each side like two bags, each containing a testicle. The latter are held aside by assistants, and the urethra having been exposed, it is dissected from the corpora cavernosa and divided at a point as far forward as may be thought safe, its end being closed temporarily by a clamp. If the disease has destroyed much of the glans, it must be assumed that the corpus spongiosum is seriously infected, and the urethra should be divided far back in the perineum. If, on the other hand, the glans has not been attacked, but involvement of the corpora cavernosa affords the indication for the operation, the urethra may be cut across more anteriorly, the corpus spongiosum being dissected from the cavernosa. The suspensory ligament is next divided, the penis drawn downward, and the corpora cavernosa stripped off the rami of the pubes with a periosteal elevator, their arteries being secured by clamps if possible before being divided. The entire organ is thus separated from its attachments and removed in connection with the contents of the groin. The end of the urethra is then trimmed off where it was crushed in the clamp, and slit up on the floor for about half an inch. If it has been divided very far back, it is secured at the posterior angle of the wound in the perineum. If it has been left long, the author generally brings it forward between the testicles and secures it on the anterior surface of the scrotum, which is then reunited in its original shape. This gives the patient a meatus where he can see it, and by taking the scrotum in his hand and holding it forward he can make use of it as a sort of funnel and project the stream over his feet without wetting himself. A small tin funnel carried about with him renders him able to use the ordinary urinals. The author has also employed the same method in some cases of amputation of the penis at the pubes, separating the urethra and bringing its end forward by splitting the scrotum part way down in order to secure it in the same manner. In order to accomplish this it is not necessary to leave the urethra very much longer than if it were secured in the stump in the usual manner, and the method gives a far better functional result.

When the urethra has been thus secured the ligatures are applied and the wound closed by sutures, the whole acquiring a Y-shape. It is well to apply a rather heavy compressive dressing in order to prevent edema of the scrotum, and the urine should be drawn by the catheter for the first two days in order to prevent it from soiling the dressing and infecting the wound. Otherwise, the patient requires very little care, and the catheter can even be dispensed with if desired, as the meatus is at the lowest part of the wound, and the urine is not very liable to infect the latter.

Many surgeons advise the removal of the testicles also, and there can be no doubt but that this would be desirable and would not greatly complicate the operation. It is said to add greatly to the comfort of the patient both during the wound-recovery and afterward But in practice this suggestion is not easy to adopt, because the patients generally feel that the operation for removal of the penis is very serious, and will not consent to anything more extensive, especially as they consider the loss of that organ a great sacrifice and fear to submit to what they imagine is a further attack upon their virility. As a matter of fact, however, the removal of the genitals in men of advanced years does not seem to produce any change of character, being essentially different in effect from similar operations in young individuals. Nor does it seem that the isolated cases of insanity which some have supposed to have been caused by this operation were really a legitimate consequence of it, for not only is any operation upon persons of advanced years more liable to affect the mind than is the case earlier in life, but the suffering, both bodily and mental, which patients afflicted with this disease undergo before consenting to operation is generally sufficient to account for some mental deterioration.

DISEASES OF THE MALE URETHRA.

By G. FRANK LYDSTON, M. D.

ANATOMY AND PHYSIOLOGY OF THE URETHRA.

An exhaustive discussion of the anatomy and physiology of the urethra would not be in keeping with the character of this work. There are a few points, however, that are of practical interest in the clinical and pathological study of its diseases. The urethra may be described as a musculo-membranous tube extending from the meatus urinarius to the bladder. It is divided into three portions—the penile, spongy, or pendulous urethra, the membranous, and the prostatic. The two latter constitute the fixed or deep urethra. The spongy or penile urethra is about 6 inches in length, and extends from the meatus urinarius to the opening in the triangular ligament, at which point it joins the pars membranosa (Fig. 40, *d*). The latter is about $\frac{3}{4}$ of an inch in length, and extends from the anterior to the posterior layer of the triangular ligament (Fig. 40, *d*); the remainder of the canal is included in the prostatic portion, which is about $1\frac{1}{4}$ inches long (Fig. 40, *e*). The meatus urinarius is the narrowest portion of the canal, and serves the purpose of directing the outflowing semen and urine. The meatus varies considerably in size. A small meatus is not necessarily an indication for a surgical operation, but when a small-calibered orifice is associated with urethral disease or reflex disturbance of the genito-urinary tract, a congenital contraction of the meatus at once assumes surgical importance. The meatus is sometimes narrowed because of the comparatively great thickness of that portion of the glans forming the floor of the fossa navicularis, the latter being the relatively dilated portion of the urethra situated within the boundaries of the glans penis and terminating at the junction of the latter with the corpora cavernosa. In other cases the relative narrowness of the meatus is due to a thin membranous fold at the inferior commissure of the orifice. This is dilatable, and offers little or no resistance to instrumentation, the contrary being true of the variety of narrowing previously mentioned. Narrowness of the meatus is generally congenital, destructive ulceration being, however, a fre-

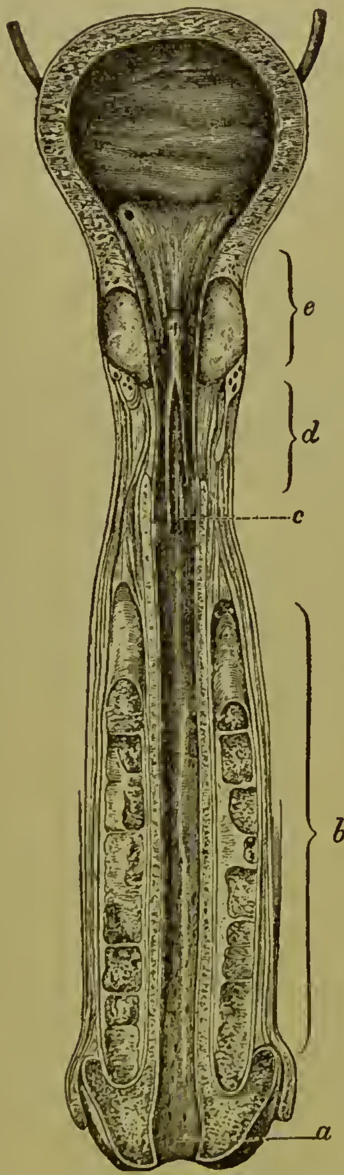

Fig. 40.—*a*, fossa navicularis; *b*, cavernous portion; *c*, bulbar enlargement; *d*, membranous portion; *e*, prostatic portion (Finger).

quent cause of acquired contraction. In some instances the canal is relatively narrow because of the presence of a congenital band just within the meatus, the orifice proper being fairly dilatable.

The spongy urethra is so called because of its investment by the corpus spongiosum. The mucous membrane of this portion of the canal is abundantly supplied with mucous glands and ducts. These, when infected, are likely to become dilated and their orifices more or less obstructed, with a resultant accumulation of infectious products in the glandular tissue proper. Latent infection and successive auto-inoculations with gonorrhea are often thereby explained. As is well known, these ducts and follicles may be so dilated that they catch the points of instruments employed in exploration of the urethra. They may also be the starting-point of urinary abscess and fistula. Their abundance and the difficulty of rendering them aseptic offer a logical explanation of the obstinacy of some cases of urethritis.

The membranous portion of the canal is invested by relatively powerful layers of longitudinal and circular muscular fibers—the compressor urethræ and accelerator urinæ muscles. On this account it has been sometimes termed the muscular portion. The function of the muscular structure of the urethra is very important. That of the membranous urethra constitutes the true sphincter of the bladder. This is under volitional control, but in rather a peculiar fashion. It would seem that the sympathetic nerve-fibers supplied to the muscle are responsible for its normal tonicity. Voluntary nerve-fibers supplied to the part enable the patient to inhibit the normal contraction at will, as a consequence of which the steady pressure or normal tonus of the destrusor urinæ muscle is enabled to overcome the slight remaining resistance of the true vesical sphincter, with resulting voluntary micturition. Direct or reflex excitation of this portion of the canal is likely to result in retention of urine. Conversely, paralysis of the pars membranosa produces urinary incontinence.

The prostatic portion of the urethra will receive attention in connection with the anatomy of the prostate. The principal diseases of this part of the canal will also receive consideration as prostatic rather than urethral affections.

While the urethra is, under normal circumstances, a urinary organ, it is by no means necessary to the function of micturition. It is, however, quite necessary to the procreative act. The urethra is, therefore, a sexual rather than a urinary organ.

The length of the urethra as given by most anatomists is from 8 to 9 inches, but the greatest discrepancy exists upon this particular point. A table showing the estimates of various clinical observers would show a marked variance of opinion. A difference of from 20 to 30 per cent. in the estimated measurements of equally competent observers is not unusual, and is hardly to be wondered at. It is probable that no two observers can possibly obtain precisely similar conditions for measurement. The penis varies in size not only in different subjects, but there is the greatest imaginable variation in the same subject under different psychological conditions. The same conditions affect the caliber of the canal.

The individual urethra is a law unto itself as far as its length is concerned. The length of a particular urethra may be said to be the distance from the meatus traversed by the catheter before the urine begins to flow, the penis being flaccid and subjected to a degree of tension merely sufficient to afford adequate support during instrumentation. Due allowance should be made for sexual excitation or emotional inhibition of blood-supply.

The consideration of the physiological functions of the urethra bears a very important relation to the study and treatment of its diseases. It is well to remember that while the urethra is of greater sexual than urinary importance, both functions must be taken into consideration in the pathology and therapeutics of the canal. Were it possible to inhibit for the time being the function of urination and to bring the sexual function of the urethra under complete control, diseases of this part would be of trifling importance and their treatment simplified. It is safe to say that the diseases of no other structure of the body are treated upon such irrational principles as those of the urethra, because of the necessity of mechanical disturbance of the canal at variable intervals in the act of micturition and the difficulty of repressing sexual emotions and stimuli, to say nothing of the frequency with which the patient is exposed to the mechanical dangers incidental to actual intercourse.

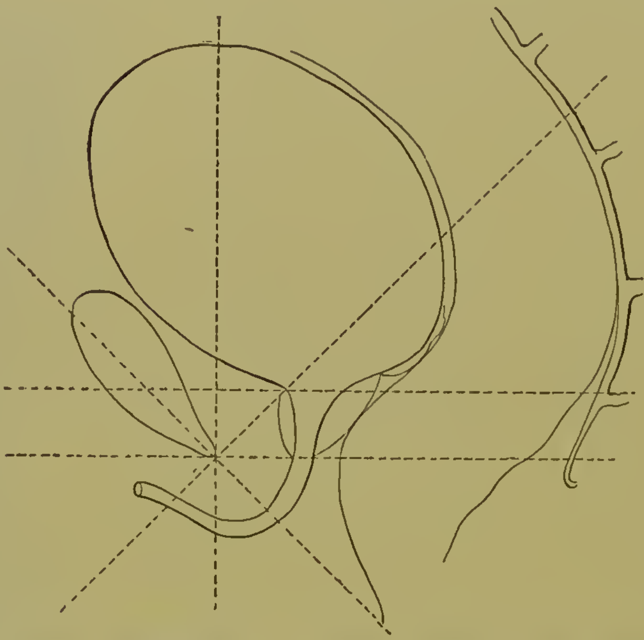

FIG. 41.—Schematic representation of urethral curve and its relation to the symphysis pubis (Tillaux).

The anterior curve of the urethra is not of great importance with relation to instrumentation, as it can be adapted to almost any form of instrument. It is different, however, with the posterior or deep curve (Fig. 41), which is relatively fixed; it cannot be said to be constantly fixed, for, as is well known, straight instruments can be introduced into the bladder. The fixed urethral curve is not uniform, but varies widely with the period of life and the condition of the prostate body. It is comparatively short and sharp in the child, much longer and less abrupt in the adult, these characteristics greatly increasing in prominence as the subject grows older. In prostatic enlargement the curve becomes so greatly elongated as to necessitate considerable modification of instruments and manipulations for entering the bladder. This point is of the greatest practical importance to the genito-urinary surgeon. The direction and conformation of the pendulous urethra may be modified by changes in the position of the penis. It may also be adapted to any form of instrument necessary for urethral or bladder manipulation.

The average normal curve, as established by Bell and verified by Thompson, Van Buren, and others, corresponds to a circle 3¼ inches in diameter, the proper length of curve for adaptation to the deep urethra being an arc of such a circle subtended by a chord $2\frac{3}{4}$ inches in length. The length of curve advised by Thompson is generally too long for instruments. The shorter the beak of the sound, providing it be adapted to the normal curve, the more thoroughly under control will the instrument be during instrumentation.

The author takes the opportunity of stating at this point his belief that the majority of surgeons have a very exaggerated estimate of the length of the urethra from the standpoint of instrumentation. As a result of this fallacious belief, instruments for vesical and urethral exploration are much too long upon the average, and it is probable that considerable damage results therefrom.

One of the most important structures in relation with the urethra, from a surgical standpoint, is the deep layer of the superficial fascia of the perineum. This was first described as a special fascia by Gurdon Buck, and is generally known as Buck's fascia. It is attached to the rami of the pubes and ischia laterally, and to the triangular ligament behind, in such a manner as to limit extravasations of urine, blood, or pus to the perineum. Buck's fascia is continuous with the fascia abdominalis above; hence it is possible for fluids to burrow in this direction alone as long as the fascia is intact below. This special fascia splits into two layers that enclose the corpora cavernosa and corpus spongiosum before it dips downward into the perineum.

The triangular ligament is another special fascia of importance. It is really the deep perineal fascia. It is divided into two layers, the compartment between which contains the membranous urethra and Cowper's glands.

INJURIES OF THE URETHRA.

The subject of traumatism of the urethra, while in the strict sense of the word a surgical one, is very important for the consideration of the general practitioner, especially as he is quite likely to be first upon the scene, and is liable to be led into the belief that certain injuries are of trifling importance when, as a matter of fact, they require the immediate attention of a surgical expert. It is by no means cases in which serious swelling, pain, and perhaps retention of urine occur that alone require careful surgical treatment. A knowledge of their possible gravity, ultimate results, and the proper method of management of traumatisms of the urinary canal is of the greatest importance, not only because of the immediate gravity of many cases, but because of the more remote yet serious results that may follow apparently trivial injuries.

Possible results of urethral traumatism.

- Hemorrhage;
- Retention of urine;
- Extravasation of urine;
- Sloughing;
- False passages;
- Urethritis;
- Pus-infection and abscess;
- Urinary fistula;
- Permanent curvature of the penis;
- Stricture of the most intractable form;
- Fatal sepsis.

The urethra may be contused, lacerated, or cut either from internal or external violence. Internal injuries are generally the result of surgical interference with the canal; occasionally, however, the patient wounds his urethra by the introduction of foreign bodies of various kinds. The penile urethra is only exceptionally injured by external violence, on account of its extreme mobility. The deep urethra is frequently injured by falls or blows upon the perineum, the bulbo-membranous region being caught between the impinging body and the sharp lower border of the subpubic ligament. A slight blow in this region may produce serious injury.

The urethra is occasionally cut or lacerated from external blows with sharp instruments.

Treatment.—In all injuries of the urethra, however slight they may seem, the practitioner must have in view the danger of subsequent stricture. This may be averted by systematic sounding during the healing of the wound. Hemorrhage may be controlled by pressure, the ice-bag, or the retained catheter. If the injury be at all extensive and a catheter can be readily passed, it should be retained in the bladder for a few days, after which the danger of extravasation will have subsided. Systematic dilatation should now be substituted for the retained catheter. If the penile urethra be extensively lacerated, a perineal puncture should be made for vesical drainage, and the lacerated tissues should be stitched in layers over a soft catheter or a piece of rubber tubing. The perineal tube may be removed at the end of a week. Primary union may be expected from this procedure.

In all urethral injuries great care should be taken in passing instruments, lest the lacerated tissues be torn up and a false passage thereby made.

In deep urethral injuries a catheter should be carefully passed and retained for a week or more, after which dilatation should be begun. If great difficulty be experienced in passing the catheter or if the injury be severe, perineal section is indicated. If it be possible to suture any portion of the divided urethra, this procedure is advisable. The author is of opinion that perineal section is by far the safest method of treatment for the majority of cases of injury to the perineal portion of the urethra. Should extravasation of urine be suspected, perineal section is imperatively necessary.

In the management of all cases of urethral injury the strictest attention should be paid to asepsis and antisepsis. The most important practical point in connection with urethral traumatism is the fact that stricture of the canal often follows injuries which are so trivial as to attract little or no attention at the time of their infliction. Careful attention may obviate this untoward result.

The author desires especially to emphasize the desirability of systematic dilatation after all injuries of the urethra that are sufficiently marked to attract attention. If this plan be followed, serious traumatic stricture will often be prevented.

FOREIGN SUBSTANCES IN THE URETHRA.

It would require much more space than the subject demands to enumerate the variety of ordinary and extraordinary substances that have been introduced into the urethra by patients who are actuated by curiosity or perverted sexuality. Young lads quite often introduce foreign bodies into the urethra, and these bodies, slipping from their fingers and being swallowed up by the canal, produce a degree of subsequent trouble determined entirely by the character, size, and location of the foreign substances. It is by no means exceptional for surgeons to break off catheters or other surgical instruments in the urethra. The French gum catheters are particularly dangerous in this respect, especially after they become old and brittle.

Possible results of foreign bodies.	Retention of urine; Hemorrhage; Urethritis; Ulceration; Rupture of the urethra; Sloughing; Abscess and fistula; Deposition of urinary salts and resulting calculous formation.

Treatment.—Simple manipulation, perhaps combined with meatotomy, is often successful in removing foreign bodies from the urethra. Specially constructed urethral forceps are sometimes necessary. When these means fail the foreign body should be pushed on into the perineal urethra, and a perineal section made. It is well to make the perineal section before the foreign body is pushed down, unless it be of good size, for small bodies may otherwise be forced into the bladder.

In the author's opinion, prompt perineal section is very much better practice, upon the average, than prolonged attempts at extraction of a foreign body by urethral forceps *viâ* the meatus. In the case of soft bodies it has been recommended to insert a fine needle into the urethra from without and pry the foreign body outward toward the meatus.

TUMORS OF THE URETHRA.

The urethra is occasionally the seat of new growths of various kinds. Since endoscopy came into vogue urethral tumors have been found to be much more frequent than had previously been supposed. These tumors vary in degree and gravity from small inflammatory neoplasms to malignant growths.

Inflammatory neoplasms are usually concomitants of chronic urethritis, and, as Dittel long ago showed, are occasionally associated with organic stricture. As he originally described them, these neoplasms consist of an overgrowth of the connective tissue underlying the mucous membrane which projects into the lumen of the canal. They are richly supplied with bloodvessels, and are covered with epithelium similar to that found in the normal urethra. Fungous or papillomatous excrescences are sometimes formed, the point of departure being apparently a granular urethritis. In some instances the vascular supply is so rich that the growth is not unlike an angioma.

In a general way, urethral growths of inflammatory origin resemble the vegetations that are met with upon the external mucous surface. The author has noted several cases in which the growth was associated with external vegetations, the urethral growth being limited to the fossa navicularis. In other instances papillomata have occurred in the anterior urethra independently of any external growth. Distinct polypi of the mucous membrane of the urethra have been met with. Such a specimen exists in the museum of Guy's Hospital, London.

It will be readily understood that prior to the introduction of the endoscope no ante-mortem diagnosis of the softer varieties of urethral neoplasm could be considered as more than guesswork. Urethral tumors, usually in the form of the well-recognized caruncle, are much more readily recognized in the female than in the male, on account of the limited length and great dilatability of the canal.

Cancer of the urethra is usually secondary to cancer of the penis, and requires no special consideration here. Several cases of primary cancer of the urethra have been reported, but they have been erroneously diagnosed until late. Such cases as have occurred have been located in the perineum, and even in these cases the urethra may have been secondarily diseased.

Grünfield has reported one case in which he diagnosed a primary cancer of the prostatic urethra by the endoscope.

Benign tumors of the urethra are usually found casually when the surgeon is seeking for a cause for a protracted urethral discharge. The symptoms of urethral tumor are those of chronic urethritis, with obstruction—if the growth be sufficiently large—and in some cases hemorrhage during micturition.

The **treatment** of urethral tumors is, briefly, removal by forceps or scissors *viâ* the endoscope or urethral speculum, with subsequent careful cauterization of the base of the growth.

URETHRITIS.

Urethritis is the most frequent disease affecting the male genito-urinary tract. It is usually contracted during sexual intercourse, and is so exceptionally acquired in any other way that it has been termed the most venereal of the class of diseases to which it belongs. The most common term for urethritis is gonorrhea. This is a misnomer, for several reasons: First, because it implies a discharge or morbid flow of semen; second, because it implies a disease of an unvarying type of specificity. The generic term urethritis is accurate as applied to the affection in the male, inasmuch as it not only implies an inflammation of the urethral mucous membrane, but is sufficiently comprehensive to embrace all the varying forms of the disease whatever their origin. Neisser's discovery of the gonococcus has, however, in all probability permanently fixed the generic term gonorrhea in its application to a specific type of inflammation affecting the mucous membranes in both the male and female. If we accept the specific character of the gonococcus, a broad line of clinical differentiation is at once established in urethritis. We are still compelled to recognize, however, certain cases in which the presence or absence of the gonococcus cannot be accepted as proving or disproving the venereal origin of the disease. This is especially true in cases in which the affected individual has indulged at more or less frequent intervals with different females, and has suffered from previous urethral infection. Under such circumstances the recent attack may have been due to the development of gonococcal auto-infection from a focus originating in some prior attack of inflammation. In other instances the patient presents himself with a non-gonococcal discharge, and we are called upon to decide as to its specificity. Here we are compelled to acknowledge that the gonococci may have been present, but have disappeared. Practically, therefore, we are often essentially in the same position as before the discovery of the gonococcus. Especially is this true from a medico-legal standpoint. The sources of error in the diagnosis of the origin of urethritis are so numerous that it is never safe to pronounce a case of urethritis to be of specific origin, whether the gonococcus is present or not, unless the affected individual can be shown to have been perfectly healthy before the development of the urethritis, or to have had intercourse with a woman suffering from virulent vaginitis—proven by microscopic examination of her vaginal secretions—or to have a history of a more or less recent attack of gonorrhea. This caution is particularly necessary in passing an opinion in the case of a married person.

The discovery of the gonococcus has not changed the views of the author regarding the origin of gonorrhea and its congeners. This class of affections, in common with chancroid, may still be classed as filth-diseases which originate *de novo* in the female. The author believes that germ-infection of one kind or another is the *fons et origo* in the majority of cases of urethritis. It is not probable, however, that the germs producing such infection are always and invariably the same. Gonorrhea is probably as old as the human race, but the development of the gonococcus—and, indeed, of all germs capable of producing urethral inflammation—has been along evolutionary lines. We cannot accept the spontaneous generation of germs of either indeterminate or specific type. We may, however, believe in the transformation of innocuous germs, by virtue of their adaptation to environment, into germs of a specifically pathogenic character. The female generative apparatus constitutes the most favorable environment for the development of germs, and their acquirement of pathogenic properties, that could be imagined. Protection from air and light and the presence of heat, moisture, and decomposable secretions of various kinds constitute excellent conditions for bacterial evolution. Pathological discharges and exposure of the parts to sources of local irritation constitute an additional and important factor. In uncleanly women, vaginal discharges, as well as both pathological and physiological discharges of the male, are allowed to accumulate and undergo decomposition. The semen is a highly complex organic substance, the decomposition of which in all probability results in the development of toxins of a highly irritating character.

When the author uses the term *de novo* as applied to chancroid and gonorrhea, he does so with the full understanding that both are germ-diseases, and that, consequently, spontaneous generation of these diseases in the sense of the development of their germs *de novo* is an utter impossibility. He believes, however, that the perfected germs of these affections represent the acme of spontaneous cultivation of germs which were primarily quite different, from a pathological standpoint at least, from the final product. Evolutionary changes, and especially differentiation of biological and pathogenetic properties in germs, must be admitted, for we must necessarily apply the same law to the parasite as to the host. It is very interesting to the author to observe that the views which he expressed some years ago upon this subject in an article entitled "The Evolution of the Local Venereal Diseases" are being daily substantiated by the practical results obtained by bacteriologists in the laboratory. A recent case coming under the author's observation appears to be an illustration of the fact that the germ of gonorrhea is capable of transformation.

The case was that of a young man who had been troubled with posterior urethritis and stricture for nearly two years. From time to time, within the past year, his semen had been examined by several very competent microscopists and had been said to contain gonococci. Several months after a urethrotomy the patient's semen was examined, and found to contain germs strongly resembling the gonococcus. Closer study, however, showed that they were slightly rod-shaped, although typically paired, like the diplococcus of gonorrhea. Cultures and experimental inoculations showed that the microbe was pathologically inert, and the patient was assured that he might marry with safety—a point of great importance to him, as he had been contemplating matrimony. Did we not have in this case an illustration of a spontaneous alteration in the physical and pathogenic properties of the gonococcus? The case is at least a suggestive one along the lines mentioned. It is of such practical importance that the author is inclined to believe that test-cultures and inoculations should be made in prolonged cases in which the presence or absence of the gonococcus is to be accepted as the criterion of cure or of the safety of matrimony.

Whether or not the gonococcus be accepted as the cause of a certain specific type of urethritis, the fact remains that the environmental conditions that have been mentioned constitute the point of departure of germ-evolution, the products of which are capable of producing mucous inflammation of varying grades of severity, ranging from a simple form of urethritis to the gonococcal variety of virulent inflammation. Precisely what germ is the progenitor of the gonococcus in the process of evolution would be difficult to determine, but the difference between the specific microbe and certain germs that are normally present in the urethra of the male and the vagina of the female is not very great. The dissimilarity between the gonococcus and the pus-microbe is not so marked as to exclude the possibility of the transformation of the one into the other under favorable circumstances of environment. That we are unable to imitate this process of evolution is not a valid argument against the theory.

Varieties of Urethritis.—Inflammation of the urethra may be divided for description as follows:

- Acute and chronic,
  - (*a*) Simple,
    - Bacterial;
    - Toxic;
    - Chemical;
    - Traumatic.
  - (*b*) Specific,
    - Gonococcal;
    - Chancroidal;
    - Syphilitic.

Simple Urethritis.—Simple urethritis is rather an omnibus term, on account of the large number of causes upon which the condition may depend.

Predisposing Causes.—1. Diathetic conditions; 2. Chronic urethral disease; 3. Morbid states of the urine; 4. Sexual abuses; 5. Dietetic excesses and irregularities; 6. Alcoholism. It is obvious that any condition of the system which gives rise to irritability of the mucous membranes predisposes to inflammation of these structures. It is possible that this argument cannot be applied with equal pertinency to all mucous membranes, but it certainly applies quite forcibly to the urethra. Especially is this true of such diathetic conditions as rheumatism and gout, in which the urine is likely to be loaded with the products of retrograde tissue metamorphosis, which products may be both mechanically and chemically irritating. Lithemia and oxalemia are especially potent factors in this respect, producing as they do their corresponding conditions of perturbation of the composition of the urine—namely, lithuria and oxaluria. The urine in lithemia is not only likely to be heavy and concentrated by virtue of its disproportionate amount of solids, but the uric-acid crystals present are exceedingly irritating to the mucous membranes of the genito-urinary tract. There is no question but that lithuria is responsible for certain catarrhal conditions of the upper portion of the genito-urinary apparatus. This catarrhal condition is possibly not so manifest in the urethra, yet the mucous membrane, by virtue of the irritating properties of the urine, is in an extremely vulnerable condition. This constitutes a standing invitation to infection and sources of irritation of all kinds. Irritability of the nervous supply of various tissues—which means essentially irritability of the tissues themselves—is another important factor incidental to the gouty or rheumatic diathesis. Closely associated with the gouty diathesis are the effects of dietetic indiscretions and excesses and indulgence in alcoholic beverages.

The author is of opinion that gout and rheumatism are much more intimately associated with urethritis than is ordinarily supposed. Either or both of these conditions may be a powerful factor in cases in which the exciting cause is undoubtedly specific infection. It is well to remember this, as it is quite often a very important guide in treatment. By taking this factor into consideration some hitherto rebellious cases may often be brought under control. It is certain that the rheumatic and gouty diatheses are of especial importance with relation to inflammation of the mucous membranes. It is not claimed that their importance is as great in the case of the lower portion of the genito-urinary tract, and especially of the urethra, as in the case of the throat, but in a general way it is well to remember that the same pathological principles that govern the relation of rheumatism to acute or chronic inflammation of all other mucous membranes apply to the study of urethral disease.

As is true of all organs of the body, excessive action is a predisposing cause of inflammation. In the case of the urethra sexual excesses and masturbation are the source of much mechanical disturbance, glandular hyperactivity with excessive secretion of mucus, and possibly slight traumatisms, these various factors causing a catarrhal state of the mucous membrane that affords an excellent soil for microbial action and exaggerates the results of irritation of all kinds. The element of unrest is of far greater importance in the consideration of the predisposing causes of urethral inflammation than is usually accorded it. The majority of men do not seem to entertain the slightest idea of the possibility of overstrain of the sexual apparatus, and it is well for the practitioner to at least attempt the education of his patients in this particular direction.

By far the most important factor in the predisposing causes of simple urethritis is chronic disease of the genito-urinary tract, whatever its origin may have been. Most of the cases of simple urethritis are due to the effects of sexual, alcoholic, or dietetic excesses upon a urethra already damaged, and in which the products of microbial action, particularly the products of simple decomposition, are present. This must be remembered as bearing very pertinently upon cases of suspected gonorrhea in which the virtue of one or both parties to the venereal act may be brought in question.

Exciting Causes.—1. Trauma; 2. Bacteria (non-specific); 3. Toxins; 4. Chemical irritation; 5. Sexual strain. It is unnecessary to expatiate upon traumatism as a factor in the production of urethritis. It should be remembered, however, that traumatism in a perfectly healthy and approximately aseptic urethra may be followed by little or no inflammation; often, indeed, by no phenomena that can be properly characterized as urethritis. In the presence, however, of some latent condition of disease—*i. e.* a chronic source of infection—traumatism bears a very important relation to the etiology of acute urethritis. A very pertinent illustration of the relation of traumatism to pre-existing conditions of infection of the urethra is found in the results of operations or instrumental manipulations of the canal in the presence of stricture or congested and granular patches on the urethral mucous membrane.

In considering the relation of bacterial infection to simple urethritis it is well to remember the fact that various forms of bacteria and their products are capable of producing irritation and inflammation of mucous membranes.

The pus-microbe or its derivatives, and possibly the ordinary germs of decomposition, may, *per se* or by virtue of their products, produce urethritis. The author will not discuss here the relation of the bacterium coli commune to inflammations of the genito-urinary tract. It is highly probable that the line of demarcation between the pus-microbe and the colon bacillus would be very difficult to demonstrate. A point worthy of consideration is that the secretions from disease of the urethra, originally of gonococcal origin, but from which all specific characters have disappeared (as in certain cases of chronic urethritis, folliculitis, and prostatitis and in certain inflammations of the female genito-urinary tract), are capable of producing inflammation of the male urethra. That the toxins evolved by microbic action may cause urethritis is almost, if not quite, certain. Any chemical irritant may produce urethritis, which may assume a severe type. The well-known experiment of Swediaur with aqua ammoniæ will be remembered in this connection.

In discussing the exciting causes of simple urethritis it is necessary to correct the fallacious notion that normal secretions in the female are capable of exciting urethritis in the male. It is nothing unusual for the apology to be offered that the affected man has had intercourse with a woman just before, after, or during the menstrual discharge. The inference that the menstrual discharge may produce urethritis is as old as the Bible, as will be noted by a perusal of the fifteenth chapter of Leviticus. The Jewish tradition that the female is unclean for a certain period following menstruation is probably based upon this common but erroneously applied observation. Menstrual fluid, unless decomposed or mixed with the products of bacterial evolution of one kind or another—whether the germs be autogenetic or heterogenetic is inconsequential—cannot possibly produce urethritis. Apparent contradictions are due either to the autogenesis of urethritis in a previously damaged urethra, or to the washing down of the products of an old infection from the upper portion of the female sexual tract by the outflowing menstrual secretion. The menstrual secretion has been accepted as an etiological factor in urethritis; the water-closet theory has been repudiated, but the author entertains the belief that the latter has at least a basis of probability, while the former is positively absurd.

The "strain" theory of the origin of urethritis is a very popular one, but is perhaps the most fallacious of all. It is probable that sexual excess alone is never productive of the disease. Sexual excess in the presence of a diseased urethra is, however, another matter, and under such conditions is a very important factor among the exciting causes of urethritis. As a predisposing factor, on the other hand, it is all-important.

Gonococcal or Specific Urethritis.—*Predisposing Causes.*—These are precisely the same as those enumerated for simple urethritis. It is well to give special consideration to alcoholic indulgence as a predisposing factor in specific urethritis. The promiscuous exposure to infection indulged in by the majority of men who patronize the class of females from which urethral disease is generally contracted is, as a rule, associated with the free use of stimulants. It is by no means unusual to meet with patients who are in the habit of regular sexual indulgence with prostitutes, but who escape infection excepting on such occasions when the exposure is accompanied or followed by a prolonged drinking-bout, such exposure being with the same class of females—and often indeed with the same individual—as during their intervals of sobriety.

Exciting Causes.—The author will not enter into a discussion of the various arguments relative to the specificity of the gonococcus. It is sufficient to say that certain types of virulent urethritis are characterized by the presence of a germ of peculiar character—the gonococcus—and this microbe may be the cause or the effect of the disease. Whether it be the cause or effect, however, it has been conclusively shown that this microbe is capable of producing in a perfectly healthy mucous membrane an inflammation similar to that from which the secretion that contains it was originally derived.

Apropos of the method of contagion in gonorrhea, it has seemed to the author that considerable illogical reasoning has been indulged in regarding the possibility of infection with gonorrhea in an innocent manner. Syphilis *insontium* is well recognized, but whenever an individual presents himself with a gonorrhea and gives a history of unknown or innocent source of infection, the practitioner treats the history with lofty disdain and a contempt born of profound knowledge of human nature, particularly as manifested in venereal diseases. The author unhesitatingly affirms that, other things being equal, gonorrhea is more likely to be contracted innocently than is syphilis. The principal limitation of the application of this statement is the fact that the structures susceptible to gonorrhea are of comparatively small area and not very readily accessible, whereas in the case of syphilis any abraded surface will serve as a port of entry for the germ-disease. Granted, however, the contact of the mucous membrane with gonorrheal virus, infection very much more readily occurs than in the case of syphilis, the latter disease requiring an abrasion as one of the essential requisites for infection. Admitting that the gonorrhea depends upon a very virulent germ, or even laying the germ-theory aside for the moment and accepting the broad proposition that gonorrhea affords a secretion which is extremely virulent, it only remains to show that the facilities for the innocent conveyance of the disease are of daily occurrence in order to substantiate the proposition that gonorrhea may possibly be contracted in a perfectly innocent manner.

The water-closet theory of the origin of gonorrhea has received much ridicule, yet the author is inclined to the belief that if logic rather than ridicule be applied to the study of the question, the theory will not appear quite so absurd. It is a practical impossibility for an individual affected with gonorrhea to use the public closets found in saloons and hotels without leaving more or less of the virulent discharge behind him. The meatus urinarius is dragged over the closet-seat in such a manner as inevitably to deposit more or less secretion, unless the patient be much more careful than the average man. The next individual who uses the same convenience will in the majority of instances, unless extremely painstaking, inevitably bring his meatus urinarius in contact with the infectious surface. Is it illogical to suppose that gonorrheal infection may occasionally occur in this manner? We are entirely too prone to question the veracity of the patient. Ridicule is hardly a safe argument as applied to a question that can be reasoned upon quite as logically as can the subject of infection of any other kind. The author unhesitatingly affirms that this is important from a medico-legal standpoint. The man who goes upon the witness-stand and offers expert testimony to the effect that any individual might not possibly have contracted gonorrhea in the innocent manner above described must certainly depart from the ordinary rules of logic, and, however profound his knowledge of bacterial infection in other directions, must necessarily manifest upon this question the densest ignorance of sound pathological and bacteriological principles. The same argument is pertinent, although perhaps not equally so, as applied to possible innocent infection of the female. The author is well aware that this statement is likely to be received with derision, but, as already stated, ridicule upon a question so open to logical reasoning as the one under consideration is hardly worthy of respect. The possible medico-legal application of the author's opinion has received due consideration, but has by no means weakened the conviction above outlined.

Accepting the gonococcus as the most definite etiological factor that has thus far been determined in virulent urethritis, it becomes necessary to consider its characteristics. During the last quarter of a century several authors have claimed to have discovered the germ or organism upon which the disease depends, but none of their views have been generally accepted by the profession until recently. The most prominent aspirant to honors in the microscopical study of urethritis is Neisser of Breslau, who in 1879 asserted that he had discovered the specific microbe of gonorrhea, which he termed the gonococcus. Numerous European bacteriologists published confirmatory reports regarding this micro-organism, and during the last few years many competent investigators have endorsed the views of Neisser. At the present time the profession has quite generally accepted the specificity of the gonococcus. The specific micro-organism is found in the pus-corpuscles. Its detection under the microscope was first made possible by certain complicated processes of staining. A little later the bacillus was found in the following rather simple manner: a drop of pus is spread into a thin layer by pressing between two glass slides, and allowed to dry in the air. A drop of solution of methyl-blue in anilin-water is now placed upon it for a moment and washed off with a stream from a wash-bottle. A few drops of Gram's iodo-iodide liquid is then poured on and allowed to remain for several minutes; this fixes the color of micro-organisms in general. Gram's liquid is now washed off, and, while the specimen is still wet, a cover-glass is placed upon it and it is examined with an oil-immersion lens. If micro-organisms resembling the gonococcus are found, they are tested by decolorization. The cover-glass is removed, and the specimen treated with absolute alcohol until the color is as completely removed as possible. The cover-glass is replaced and the specimen examined, when all the gonococci will be found to have disappeared; all other organisms will be distinctly visible.

The gonococcus, as described by Neisser, was developed from the pus-corpuscles by staining with methyl-violet and dahlia. It is located generally upon the surface of the pus-corpuscles; more rarely upon the surface of the epithelium. Sometimes it is incorporated with the corpuscle and replaces its nucleus, which disappears. The microbe is large and spherical when single; in some instances two of them unite together in a sort of biscuit shape. They are usually found in colonies of ten to twenty or more, surrounded by a species of mucous envelopment. For practical purposes the simpler methods of examination of suspected fluids are best. A drop of pus, placed upon a cover-glass, may be spread into a thin layer by placing another glass upon it and sliding the two apart. One of the glasses is then thoroughly dried by passing it rapidly through the flame of a spirit-lamp. The cover-glass is now dipped in a solution of methyl-blue, and the superfluous coloring matter washed off by a stream of cold water. It should now be mounted in Canada balsam.

Neisser has more recently laid especial stress upon the tendency of the gonococci to arrange themselves in pairs. This, he claims, distinguishes them from the urethrococci, which are found singly or in irregular clumps. He also says that the gonococci are found in or upon the pus-corpuscle, never outside of it. One important source of fallacy at once suggests itself. It is by no means improbable that the urethrococcus may undergo modification by virtue of the existence of a virulent inflammatory process, as a consequence of which it tends to arrange itself somewhat differently and to invade the pus-corpuscles. This is certainly consistent with the evolutionary theory. Taken singly, the urethrococcus and gonococcus are identical in appearance. At present, however, the gonococcus is universally recognized as a diplococcus (Fig. 42).

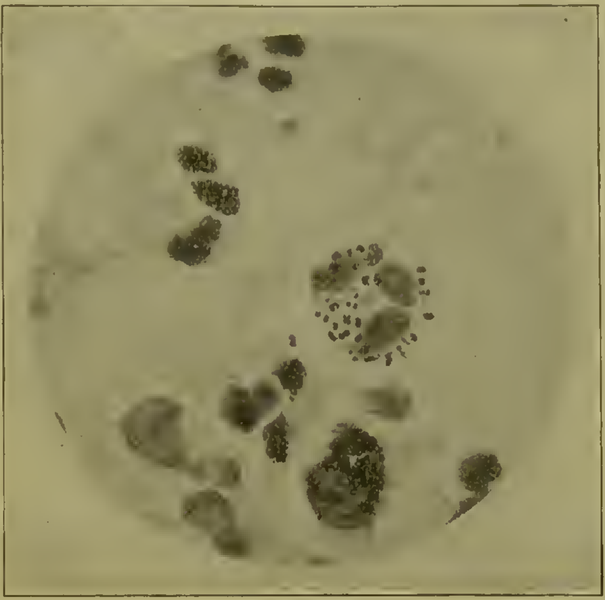

Fig. 42.—Gonococci.

Morbid Anatomy of Urethritis.—Inasmuch as the anatomical features of specific and simple urethritis differ in degree only, the morbid anatomy of the disease in general may be properly taken up at this point. The infection of urethritis is generally supposed to begin at the meatus. Milton has remarked the apparent contradiction of urethral chancre and chancroid as regards the site of inoculation. He believes that in such cases the virus is deposited at the lips of the meatus, and subsequently diffuses itself until it meets with a susceptible portion of mucous membrane. It is a question whether morbid secretions may not be drawn into the urethra during coition. The author believes that they may be. It would seem that a certain amount of aspiration is produced in the urethra during the venereal orgasm, sufficient at least to draw secretions from the vagina into the urethra. The alternate contraction and relaxation of the deep perineal muscles incidental to the efforts of the urethra to clear itself of semen during the venereal act must necessarily produce a more or less marked suction at the meatus. It is the author's impression that the inflammation often really begins in the fossa navicularis rather than at the meatus proper.

The extent to which the urethra is involved is variable. The inflammation is generally most marked in the anterior portion of the canal, but in the severe types almost always involves the entire canal down to the bulbo-membranous junction, and in many cases extends to the posterior urethra. The entire mucous membrane of the urethra from the meatus to the bladder may be infected. In the milder forms of urethritis the pathological changes consist in a few instances of slight hyperemia with attendant reddening and hypersecretion. In by far the majority of cases, however, there will be found chronic changes in the canal produced by a previous attack of virulent urethritis. The pathological anatomy of simple acute urethritis and that of chronic urethritis are therefore usually identical. In simple urethritis with a chronic inflammatory foundation the localization of the chronic inflammation, with perhaps the formation of stricture or abraded, granular and congested patches, is due to several causes: (1) The most important is the relative inelasticity of the portion of the urethra involved. This produces friction during micturition, with consequent localization of the inflammation at the particular point affected. (2) Dilatation and severe inflammation of mucous follicles at one or more points in the canal. (3) Injury of the canal at different points, due to the introduction of instruments, the long-nozzled syringe being the most frequent cause. (4) The spontaneous or traumatic yielding of the corpus spongiosum in the course of chordee. (5) Slight thickening of the urethra due to previous traumatism. In cases in which posterior urethral infection—prostatitis—has occurred in the course of acute gonorrhea more or less enlargement of the organ is found, together with a varying degree of interstitial thickening and chronic inflammation in the prostatic ducts and follicles.

In the severe forms of urethritis the principal change consists in intense hyperemia, with swelling of the mucous membrane. This is attended by a diminution in the caliber of the canal that may result in complete retention of urine. When the inflammation is at its height there exists an infiltration of the corpus spongiosum resulting in thickening and inelasticity of that structure. Late in the history of the case this plastic infiltration either disappears entirely or, as is very frequent, localizes itself at certain points. These points are usually the posterior portion of the fossa navicularis, the lacuna magna, and the bulbo-membranous junction. Other points in the pendulous urethra are frequently involved. It is in these situations that we are most likely to find stricture. The follicles of the urethra are found to be dilated and filled with purulent or muco-purulent secretion. Herpetic excoriations are occasionally seen. In view of the severity of the inflammation in some cases it is singular that true ulceration does not more often occur. It is, however, very rare. The epithelium lining the urethra will be found abraded here and there in all cases in which the inflammation is of a high grade. In some instances it is almost entirely removed throughout the extent of the canal. Superficial erosions of the mucous membrane result from abrasion of the epithelium. In chronic cases the pathological factors that are most important in explaining the persistency of the disease are stricture, congested and granular patches, enlargement of the lacuna magna, dilatation and inflammation of the glands of Littré and sinuses of Morgagni, and follicular prostatitis—*i. e.* so-called posterior urethritis.

The tendency to the formation of granulations in the urethra is especially marked in the bulbous region. This is worthy of note, as the recognition and treatment of this condition by means of the endoscope constitute the sole hope of cure in a certain number of cases of chronic urethritis.

Incubation of Urethritis.—It would seem that the period of incubation in urethritis is rather an indefinite quantity. This, however, is due to the many sources of confusion that exist. M. Leon le Fort in a study of over 2000 cases of gonorrhea found that 50 developed within twenty-four hours, 778 within four days, 869 between the fourth and the eighth day, 276 from the eighth to the twelfth day, 112 from the twelfth to the sixteenth day, 17 from the sixteenth to the twentieth. The author does not accept these figures as accurate, but, after making due allowance for erroneous observation, the figures are still suggestive of the irregularity of the period of incubation.

It is the author's opinion that the period of incubation of true gonorrhea can be accurately studied only in cases in which there has been no previous disease. In cases in which sexual excitement or irritating vaginal discharges develop primarily simple urethritis the gonococcal element may not appear at once. A discharge that comes on within twenty-four hours, therefore, may be simple, and yet in four or five days become of the gonococcal type.

Simple urethritis may develop at any time after exposure to its exciting causes, the length of time varying with the strength of the irritant and the susceptibility of the urethra, every urethra being a law unto itself. The gonococcal type supervenes upon the simple variety or occurs primarily on the average about the fourth or fifth day after exposure. The author was at one time inclined to repudiate the incubation period altogether, but has lately come to believe in its existence in gonococcal urethritis, due consideration being given to such sources of confusion as previous urethral disease and varied exposures to possible infection.

Symptoms of Urethritis.—The symptomatology of urethritis requires but little attention. Ricord was not far from right when he said, "Anybody can tell when a gonorrhea begins, but God alone knows when it will end." Modern methods have modified this dictum of one of the masters slightly if at all.

The symptoms of simple urethritis consist of a slight or moderate urethral discharge of a muco-purulent character, with perhaps a greater or less degree of smarting on urination. The discharge develops, as a rule, shortly after venereal excesses or intemperance in gouty or rheumatic patients with damaged urethræ, or in those suffering from stricture with granular congested patches in the canal, independently of any special diathesis. It may occur in individuals possessing healthy but exceedingly sensitive urethræ as a result of contact with unhealthy and irritating vaginal secretions. It is to be remembered that the simple type of inflammation may at any time become very severe and virulent from—*first*, coincidental gonococcal infection; *second*, various sources of superadded irritation.

The symptoms of typical virulent urethritis are pronounced and characteristic. At the end of the period of incubation the patient experiences more or less itching at the meatus, with smarting on urination, and on examining himself he finds the meatus glued together with a clear, sticky deposit of mucus; during the next day an increased discharge is observed, accompanied with considerable heat and painful micturition. These symptoms gradually increase until about the fifth to the seventh day, at which time the disease reaches its maximum degree of severity. The inflammation now becomes stationary, the discharge at this time being thick, creamy, and of a greenish color, due to its mixture with degenerated blood-corpuscles. In some instances distinct hemorrhage occurs; slight hemorrhages from capillary rupture are by no means infrequent. The more virulent the case the more greenish and profuse the pus and the greater the liability to distinct hemorrhage. In some virulent cases, however, there is such a high degree of inflammation that the discharge is merely a thin, greasy, muco-sanious fluid; but as soon as the process begins to subside somewhat the discharge becomes thick, creamy, and purulent, but still of a greenish cast. It is during the stationary period of the disease that the patient is most apt to have chordee: this consists of a painful bending of the penis during erection, and is due to interstitial inflammation of, and plastic exudate into, the corpus spongiosum and the submucous connective tissue surrounding the urethra. The penis, it will be remembered, is composed of three segments, of which the two superior (the corpora cavernosa) are the main factors in erection. When the organ is erect the inflamed, infiltrated, and inelastic corpus spongiosum acts upon the body of the penis like the string of a bow and causes it to bend. The corpus spongiosum being highly sensitive, severe pain results from its own resistance to erection.

There is a popular opinion to the effect that breaking the chordee will cure the urethritis. This has probably arisen from the fact that more or less temporary benefit has been noticed from the depletion resulting from the accident, and also probably because the rupture has often occurred at a time when the disease should naturally have begun to subside. As a consequence of this popular impression, laymen who are fond of exhibiting their alleged knowledge of medicine and surgery, particularly with reference to venereal diseases, frequently advise their friends to have intercourse during the existence of a chordee or to otherwise attempt its rupture. The patient should be warned against this pernicious practice, and thoroughly impressed with the fact that such a course will in all probability result in severe hemorrhage, and inevitably in the worst form of organic stricture. Even when the mucous membrane alone is infiltrated, it becomes less elastic; consequently, when erection occurs, even without chordee, the patient experiences considerable pain. During erection slight traumatisms of the mucous membrane may occur, which subsequently become the points of departure for organic stricture. It is an unfortunate circumstance that any disease or injury affecting the penis or urethra irritates and increases the heat of the parts, and as a result of reflex action produces frequent and violent erections.

During the time the disease is at its height there may be general constitutional disturbance, a severe urethritis often giving rise to considerable fever. Pain and heat about the parts, a sense of dragging along the spermatic cord, neuralgic pain in the testicles, and a backache resembling lumbago are very frequently observed.

After remaining stationary for perhaps six or seven days the inflammation begins to decline, all of the symptoms decreasing in intensity. In the majority of carefully treated cases the discharge ceases in from three to six weeks, with the result of complete recovery. Unfortunately, however, in quite a proportion of cases there is a tendency to chronicity in spite of the best of treatment: the discharge under such circumstances becomes thinner and more watery, and persists for an indefinite period. This condition, or rather symptom, is popularly termed gleet.

Complications of Urethritis.—In considering the complications of urethral inflammation, the author will endeavor to give the main practical points without attempting an exhaustive discussion of subjects the minutiæ of which would require a very much greater amount of space than it is practicable to devote to them in a text-book. Bare allusion will be made to such complications as are taken up more exhaustively in other portions of this work. For the purpose of a systematic presentation of diseases of the urethra, however, brief allusion will be made to such complications, even at the risk of repetition of minor points appearing elsewhere.

In considering the complications of urethritis the author desires to advance the proposition that in by far the majority of cases such complications as arise are due, not to the intrinsic pathological tendencies of the disease *per se*, but to irrational general management, necessary or avoidable, or still more frequently to over-enthusiastic attempts to cure the disease. It has been the author's experience that the frequency of complications has been in direct proportion to the amount of energy expended in attempts at a cure of the disease. Under management as rational as is practicable, with a method of treatment largely expectant in cases that are fully developed, the disease is not, upon the average, attended by many or severe complications. It is safe to assume that the danger of complications in urethritis is directly proportionate to the severity of the inflammation and the degree and frequency with which the canal is mechanically disturbed. An important factor in the production of complications is the amount of exercise indulged in by the patient. In reference to the etiology of the complications, it is to be remembered that the gonococcus is by no means the principal factor. Gonorrhea is a typically mixed infection, and many of the most severe complications of urethritis are in no wise dependent upon the gonococcus, excepting in so far as the gonococcus may have been the original cause of the urethral inflammation.

The principal complications of urethritis are—(1) Severe chordee; (2) hemorrhage; (3) folliculitis; (4) periurethral phlegmon; (5) retention of urine from inflammatory or spasmodic stricture; (6) prostatitis; (7) cowperitis; (8) cystitis; (9) epididymitis and orchitis; (10) gonorrheal rheumatism; (11) gonorrheal ophthalmia; (12) gonorrheal conjunctivitis; (13) bubo; (14) balanitis and balano-posthitis; (15) vegetations; and (16) lymphangitis.

Some of these various complications are worthy of special description, but an exhaustive presentation is not practicable in a work of this kind. A few general points regarding the most important of them are, however, essential.

Chordee.—Severe chordee and distinct hemorrhage are naturally associated, inasmuch as the latter depends upon traumatism inflicted in the former condition. Chordee develops when the inflammation is at its maximum intensity, at which time the plastic exudate is most marked. It gives rise to no inconvenience excepting during erection. The pain that it produces is therefore usually experienced at night. The penis during erection may be bent to one or the other side or twisted. The principal dangers of chordee are rupture and hemorrhage, with subsequent severe organic stricture or perhaps abscess.

Folliculitis.—Localized and severe inflammation of the mucous follicles of the urethra is likely to occur at any time during acute urethritis, and sometimes in the subacute and chronic types. The condition manifests itself by small, tender, spherical, or oval swellings, from the size of a small shot to that of a pea, along the floor of the canal, especially anteriorly. The condition is due to an infection of the urethral follicles and sinuses of Morgagni, resulting in the formation of small retention-cysts containing pus and mucus. They rarely lead to serious trouble, but usually discharge themselves into the urethra. They are likely, however, to be the source of recurrent urethral infection.

Periurethral Phlegmon.—This is a frequent complication of urethritis. It consists of an inflammation of the cellular tissue surrounding the urethra, and is due to—(1) Minute rupture of the mucous membrane, with resulting periurethral infection; (2) rupture of the inflamed and infected follicle, with a similar result; (3) infection conveyed to the cellular tissue by means of the lymphatics or by migration of pyogenic microbes; (4) rupture and extravasation of the dilated and ulcerated urethra behind the stricture. All of these inflammatory complications imply either extension by contiguity of structure *viâ* the mucous ducts, or an abrasion of epithelium with resultant absorption of germ-products. Phlegmonous inflammation usually leads to suppuration, but cases occur in which resolution eventually takes place. The favorite seat of this complication is in the floor of the fossa navicularis.

Retention of Urine.—Retention of urine is essentially the same in its various phases as when arising from other causes. It depends on inflammatory swelling of the mucous and submucous tissues in conjunction with deep muscular spasm. This is the so-called congestive or inflammatory stricture, and may be precipitated by sexual or dietetic excesses or indiscretions.

Acute Prostatitis.—Prostatic inflammation is a frequent complication of urethritis, but its discussion does not properly belong here.

Cowperitis.—Inflammation of Cowper's glands occasionally occurs. It is due to simple extension of the inflammation to these glands, which lie upon either side of the urethra behind the bulb and between the layers of the triangular ligament. It is usually unilateral, but may involve both sides.

Symptoms.—The symptoms are pain, swelling, throbbing, and a feeling of tension in the perineum. Early examination detects a small sensitive tumor the size of a pea; later on the perineum becomes swollen, hard, and brawny, and it is impossible to outline the inflamed gland. Swelling, reddening, and edema of the scrotum may occur. There is likely to be considerable constitutional disturbance incidental to the close confinement of the inflammatory exudate within the triangular ligament. Suppuration usually occurs, but resolution occasionally takes place without it.

Gonorrheal Rheumatism.—Gonorrheal rheumatism is an important, although relatively infrequent, complication or sequela of gonorrhea. The possibility of its occurrence is disputed by some, but the majority of authorities admit that some individuals, who are perhaps free from predisposition to ordinary rheumatic troubles, are attacked with severe pain and tenderness of one or several articulations, attended with more or less constitutional disturbance and synovial effusion, in the course of urethritis. In others the same process attacks various tendinous and ligamentous structures. Some patients are affected with this complication with every attack of urethritis. It rarely begins during the acute stage of the affection, being most likely to occur after the disease has become chronic. The writer has known it to occur, however, within three days after the onset of the disease. Few diseases have been the source of more controversy regarding their origin than has gonorrheal rheumatism, and as yet its pathology must be regarded as *sub judice.* It does not appear to arise as a consequence of varying atmospheric conditions, from overexertion, nor, it is claimed, from any particular method of treatment of urethritis. The latter proposition, however, the author is inclined to question, from practical experience with the disease, especially in a case that recently came under observation, in which the rheumatic affection speedily followed successful abortive treatment. Its dependence upon purulent inflammation of the urethra is all that has so far been absolutely established, and it is by no means necessary that actual suppuration of the mucous membrane should be present in order to give rise to it. It is claimed that, inasmuch as it occurs independently of the ordinary predisposing and exciting causes of rheumatism, and is seen in only a small proportion of the subjects of urethritis, it must necessarily be the result of individual idiosyncrasy. There is probably much truth in this assertion.

The most generally accepted opinion in regard to the pathology of gonorrheal rheumatism is that it is a mild sort of pyemic infection, due to absorption of the products of purulent inflammation by the urethral mucous membrane. There is hardly a doubt of the correctness of this view; still, as might be supposed, it would be difficult to positively prove it. According to Neisser and others, the disease is due to secondary infection, the specific germ being said to have been found in the fluid of gonorrheal arthritic effusions. It is almost certain that some poisonous material—toxine—elaborated by the virulent germ-infection of the urethral mucous membrane is absorbed into the circulation and conveyed to the joint-structures. In some individuals these tissues are extraordinarily sensitive, and as a consequence reaction occurs in the form of arthritic effusion. Whether the gonococcus or the toxines formed by the mixed infection be the exciting cause of the affection is open to question; the author inclines to the latter view. It is probable that pus-microbes are at the bottom of those exceptional cases in which suppuration occurs, and that certain elements in the surgical treatment of gonorrhea are primarily responsible for the absorption of infectious materials. The destructive effect produced by strong injections and the rude introduction of instruments upon the epithelium covering the urethral mucous membrane has already been alluded to. When the mucous membrane is abraded or, as is often the case, almost entirely removed, it is obvious that absorption of organic poisons is greatly facilitated. Absorption probably does not occur very readily through the intact mucous membrane, even when it is severely inflamed. When once the epithelium is destroyed, however, it may easily occur. It is probable that the relative facility of absorption in certain individuals explains their susceptibility to gonorrheal rheumatism and the escape of others who are more fortunate. The immunity from the disease enjoyed by women is an evidence of the correctness of this view, for the only possible explanation of the rarity of the disease in the female that can be offered is that the relatively tough vagina and endometrium, and not the urethra, are the seat of the gonorrheal inflammation, and as a consequence absorption does not readily occur. It will be found that when it does occur in the female a typically virulent and acute vaginitis has existed and has extended into the urethra and bladder. The rheumatism does not usually follow primarily simple urethritis, and this shows that the severity of the gonorrhea bears a certain causal relation to its arthritic complications.

There is a question in the mind of the author whether gonorrheal rheumatism is always due to specific properties of the poison of virulent urethritis. The disease arises in cases in which, so far as can be learned by examination of the suspected party and from a microscopical study of the discharge, there is no reason to believe the origin of the disease to have been of a virulent character. Under such circumstances the severity of the purulent process may be as marked as though the origin of the disease were indubitably virulent infection.

It is probable that cachectic, strumous, gouty, and rheumatic patients have a more pronounced predisposition to the disease than persons who are perfectly healthy.

Symptoms.—The symptoms of the disease resemble those of rheumatic gout rather than the ordinary form of articular rheumatism. As a rule, the local evidences of the disease are not severe, and consequently the constitutional symptoms are comparatively mild, but this is not always true. The disease develops, as a rule, during the decreasing stage, and sometimes occurs during the second or third month. Some authorities claim that it occurs in from five or six to sixteen days, but in most of the cases observed by the author it has occurred later in the course of the disease. The explanation that suggests itself is that the inflammatory thickening of the urethra inhibits absorption from the surface of the mucous membrane, to a certain extent. Then, too, abrasion and removal of the epithelium are not so apt to occur within the first few days as later on, when the poisonous material has been in contact with it for some time. The products of the purulent process are not so virulent in the first few days as later in the course of the disease.

There is usually neither diminution nor increase of the urethral discharge coincidentally with the development of the rheumatism; rarely it is lessened, most probably because the patient keeps quiet after the development of joint-complications, and this in itself is likely to benefit the urethritis. It is doubtful whether gonorrheal rheumatism acts as a revulsive or derivative upon the inflammation of the urethra. It is said that when the rheumatism comes on late in the course of gonorrhea there is liable to be an increased discharge for a few days. In this matter the *propter* and *post* are probably confounded: it is more likely that from some particular cause exacerbation of the urethritis occurs with a coincident rapid formation of its toxic products; the mucous membrane of the urethra being extensively abraded at this time, absorption readily occurs and produces arthritis or other rheumatic symptoms.

The location of gonorrheal rheumatism varies in different individuals, and sometimes in the same patient in different attacks.

The structures involved, in the order of frequency, are—(1) Articulations; (2) the synovial thecæ of tendons and muscles; (3) synovial bursæ and the sheaths of nerves. Associated with the latter form we may meet with inflammation of the pericardium, the cerebral meninges, and the deeper structures of the eye. The author has seen several cases in which the eye alone was involved. A marked predilection is exhibited for the more important joints, the knee being perhaps most often affected. As a rule, the inflammation expends most of its violence upon one joint, although in perhaps the larger proportion of cases several joints are eventually affected.

Varieties.—Fournier presents a classification involving three distinct varieties of the disease, as follows:

1. Generally mono-articular inflammation, most often attacking the knee, occasionally the ankle or elbow. This form is really a passive hydrarthrosis with much effusion, characterized by very insidious development. Pain, tenderness, redness, heat, and constitutional disturbance are either absent or very moderate. Resolution takes place very gradually, and it is usually some months before recovery can be said to be complete; but even in these cases ankylosis may occur. In some instances the mono-articular form is excessively painful, is attended by marked constitutional disturbance, and tends to affect secondarily the bones entering into the formation of the articulation. The fluid in such cases is apt to contain more or less purulent material, strongly resembling that which is discharged from the urethra.

2. A variety not unlike articular rheumatism. This is accompanied by a moderate amount of local and constitutional reaction. Several of the joints are usually involved, and very often the tendons, various other fibrous structures, and the eye are implicated. The symptoms are not so severe as in acute rheumatism, and generally reaction is very mild as contrasted with the magnitude of the disturbances of the joints and other parts.

The disproportion between general and local symptoms is considered an important point in differential diagnosis. The involvement of the joints is usually consecutive, but there is none of the articular delitescence characteristic of acute rheumatism. Profuse sweating, acid urine, and excessive plasticity of the blood, which are so characteristic of inflammatory rheumatism, are usually absent in the gonorrheal variety. The serous membranes, such as the pleura, endocardium, and pericardium, are not often attacked. A favorable result generally occurs, but chronic synovitis, strumous arthritis in certain subjects, joint-stiffness, and complete ankylosis are possible sequelæ.

Fournier claims that acute suppuration does not occur in gonorrheal rheumatism; other authorities say that it is occasionally seen. The author believes that a joint may contain a moderate amount of purulent fluid, and still go on to a favorable issue without radical surgical interference, which is not apt to be the case with ordinary suppurative arthritis.

That suppurative arthritis may occur as a complication of gonorrhea the author is convinced from experience.

3. (*a*) This form consists of indeterminate transitory pains in various joints without any local or general evidences of disease. In such cases there is apt to be an exacerbation of the pain, and perhaps a distinct involvement of the joint coincidentally with increase in the urethral inflammation. (*b*) Thecitis occurs; the synovial sheaths become swollen and somewhat tender, there being moderate redness along the affected tendon in some cases. Movement of the muscle attached to the tendon is very painful. The synovial bursæ may become involved; the one lying under the tendo Achillis and another beneath the inferior tuberosity of the os calcis are most usually implicated. Patients thus affected complain of pain and tenderness in the heel. This particular symptom is not unusual in the course of gonorrhea. Myalgia, resembling the ordinary form, and perineuritis sometimes occur in the course of gonorrhea, and seem to be attributable in certain instances to the same pathological condition that gives rise to ordinary gonorrheal rheumatism. Pain in the back of a severe character, simulating acute lumbago, is very frequently seen: in the majority of instances this is due to over-stimulation of the kidneys by various balsamic preparations, sandal-wood being particularly apt to produce it. It does occur, however, in patients who have not taken such drugs. Whether reflex neuralgia would explain these cases is open to question.

Cases are occasionally seen in which gonorrheal rheumatism limits itself to a single nerve. One of the author's patients has an attack of sciatica coincidentally with every attack of gonorrhea. Attacks of simple urethritis are sufficient to bring it on in this case. The first attack of gonorrhea that he experienced was attended by sciatica of a very severe character, both nerves being involved.

It is somewhat remarkable that authorities so universally concede the comparative painlessness of gonorrheal rheumatic processes when, as a matter of fact, quite a liberal proportion of cases are attended by severe pain, and not infrequently by sweats quite as profuse as those that attend ordinary rheumatic fever. The tendency to sweating seems to be most marked at night, the only difference between the perspiration in these cases and that of ordinary rheumatism being the absence of acidity, its more prostrating character, and its greater profuseness.

Bubo.—Urethritis is occasionally complicated by bubo. As a rule, the glands enlarge but slightly and are only moderately tender. A moderate degree of tenderness in the groins, accompanied by little if any enlargement of the inguinal glands, is quite frequent in severe cases. The enlargement of the glands may increase until a pronounced inflammatory bubo develops. This is the variety of bubo formerly known as sympathetic. It is due in every instance to secondary lymphatic infection by pus-microbes. Suppuration is unusual, or, at least, pus rarely forms in sufficient quantity to produce a distinct abscess. It is the author's opinion, however, that in many cases in which a distinct bubo forms, but resolves without the formation of a clearly defined abscess, minute foci of suppuration exist throughout the gland-structure. This assertion is based upon a number of cases of this kind in which the glands have been extirpated. The foci of suppuration are chiefly distributed in the periphery of the gland. When one or more of these foci rupture externally, periadenitis and perhaps abscess develop. Suppuration is most apt to occur in strumous, tuberculous, or otherwise cachectic subjects. Patients recently syphilized are also liable to pus-formation in the affected glands. Trauma or straining efforts in lifting, and over-exertion of any kind appear to have some influence in determining the occurrence of bubo.

Balanitis and Balano-posthitis.—Inflammation of the mucous membrane of the glans penis (balanitis) and the preputial reflexion (posthitis) are frequent complications of gonorrhea. The two conditions are usually associated—balano-posthitis. These conditions are due to irritation produced by retained and decomposing secretions—usually beneath a tight and elongated prepuce—although this is not absolutely necessary.

Pus forms upon the inflamed surface, which becomes reddened, tender, and excoriated from maceration and removal of its epithelium. Ulcerations of an herpetic or chancroidal character may be formed. It is the author's opinion that typical chancroid may be developed *de novo* under a tight and inflamed prepuce. Bubo may result from the balanitis rather than from the gonorrhea on which the latter depends.

Vegetations.—As a result of prolonged irritation, combined with some peculiar instability of local nutrition—or tropho-neurosis—some patients develop fungoid growths upon the mucous membrane of the glans and prepuce. These are composed of heaped-up epithelium, covering delicate, capillary vascular loops. They are very fragile, painless, and bleed readily. They resemble the vegetable fungi in that their development is favored by heat, moisture, darkness, and filth. They are not unlike a cauliflower in their physical appearance. When the conditions favoring their growth are perpetuated they sometimes attain an enormous size. They are especially likely to develop in women. They may undergo transformation into hyperplastic tumors, particularly in women. The term venereal vegetations oftentimes applied to these growths is a misnomer, as they are in no sense venereal, and may appear in patients who have never had venereal disease of any kind. The author is, however, inclined to the belief that syphilis is often a predisposing factor independently of its local phenomena.

Balano-posthitis is very favorable to the development of vegetations, and they are quite likely to develop in any case where the prepuce is long or constricted.

Lymphangitis.—Inflammation of the lymphatic vessels of the penis occasionally occurs in urethritis. The prepuce becomes swollen and edematous, and sometimes presents an appearance identical with erysipelas. Abscesses may form along the lymphatic vessels. Occasionally the inflammation is limited to a few lymphatic vessels, and does not involve the entire prepuce.

Lymphangitis is due to secondary and probably mixed infection, rather than to the germs of the urethral inflammation *per se*.

In cachectic subjects sloughing of the prepuce and denudation of the penis may occur.

Chronic induration—indurating edema—is an occasional result of lymphangitis. This is most likely to occur in syphilized patients.

Treatment of Urethritis.—The treatment of urethritis comprises a greater variety of methods and remedies than almost any disease that could be mentioned. This fact is in itself strong circumstantial evidence of the self-limited and, as far as specific medication is concerned, incurable character of the disease. Manifold as are the panaceas and specifics for urethritis, the fact remains that no system of treatment has materially diminished the average duration and severity of the disease, excepting those measures based upon the principle of its self-limitation and an appreciation of the inadvisability and impracticability of attempts to jugulate it. Such measures of treatment have accomplished much; panaceas, nothing but injury on the average. There is scarcely a physician in practice, and probably not a man about town, but claims to have a remedy which is a specific for the "clap," the different remedies varying in position and legitimacy from the fallacious and dangerous patent injections to the more modern application of the bichloride of mercury by the retro-injection method. The author discredits the statements of those surgeons who claim to cure cases of virulent urethritis in a week or ten days, or perhaps less, quite as much as the statements of the veteran "rounder" who has a little preparation that "knocks it in three days." It is not to be believed that by any special system of medication a virulent urethritis is ever cured in any such time. The author has hunted down all the wonderful specifics that have ever been called to his attention, and has tried them all faithfully, but has not yet succeeded in finding a remedy that produces the wonderful results claimed by some surgeons and by quite a proportion of patients. Mr. Milton has well illustrated the fallaciousness of gonorrheal specifics in a list, taken from various sources, that comprises several hundred infallible remedies, all of which have been tried and found wanting.

Driving a gonorrhea to a cure is bad as well as unsuccessful practice in general, and much harm may come of it, the best results being apt to follow mild and persistent treatment and the acceptance of the inevitable for several weeks. There is but one substitute for this line of treatment, and that involves absolute rest. If a remedy is ever discovered that will cure every case, even in from three to six weeks, the event will be hailed as a surgical millennium. The author would be very well satisfied if a remedy could be found that would invariably cure gonorrhea in six weeks or so, meanwhile permitting the patient to go about his business. No matter what system of treatment may be followed, a better average result than this is apparently not to be hoped for in virulent urethritis. If, however, the surgeon includes his cases of the milder forms of urethritis in his statistics, he may achieve in a large proportion of instances the wonderful results claimed by many; and this remark is particularly pertinent when we consider the fact that the average surgeon must necessarily treat at least half a dozen cases of simple urethritis for every virulent case that comes under his observation. It will be found that, with due regard to the self-limitation of the disease and the intolerance of the urethra for harsh measures of treatment, fewer cases of chronic urethritis will be seen and fewer strictures and other sequelæ will result than with those systems of treatment that are said to cure within a few days. There are, to be sure, cases that are likely to disturb our faith in this method of management. How often we hear of some self-satisfied voluptuary who some years ago had a gonorrhea that proved obstinate to the best professional skill for months and months, but who finally recovered, and now has a prescription that has cured him of from half a dozen to twenty attacks of urethritis! The surgeon should not let such cases lessen his confidence in his own professional ability, for these men are constantly deluding themselves. The only virulent urethritis that the patient under consideration ever had was the first attack, from contagion, the subsequent attacks being bastard clap founded upon the damage done by the old-time gonorrhea. Sooner or later a second attack of virulent urethritis, or perhaps a mild case with a tendency to chronicity, is experienced by such patients, and not only explodes their faith in the erstwhile panacea, but gives no end of trouble, and necessitates for its cure surgical measures adapted to the removal of the cause of those numerous attacks that the alleged specific so readily subdued.

Notwithstanding what has been said regarding the parasitic or microbic origin of virulent urethritis, the author fails to see any astounding results in the way of improved methods of treatment; not that this is in any sense an argument against the microbic character of the disease, but it certainly signifies its self-limitation. The investigations of bacteriologists who unhesitatingly accept the gonococcus of Neisser have shown that the germ of the disease infects the entire thickness of the mucous membrane and the submucous cellular tissue so completely that repair cannot take place in well-pronounced cases until the layers of affected cells have been replaced by new and insusceptible connective-tissue cells from beneath (see Plate 2, Fig. 1). This condition of affairs proves positively that nothing short of caustic applications capable of destroying the entire thickness of the mucous membrane can by any possibility abort a virulent urethritis when once it is thoroughly established. As a corollary, it is obvious that attempts at the abortion of a virulent urethritis should be made only in the very incipiency of the disease —before, in fact, it is possible to determine whether or not we have to deal with a simple or virulent case of inflammation; for, inasmuch as the different grades of urethritis often begin in precisely the same manner, it is impossible to tell for a few hours or perhaps several days, without the microscope, whether or not we have to do with a virulent type of the affection or with the simpler and more curable variety. Any form of treatment the efficacy of which is supposed to depend upon the action of antiseptics on the specific germs of the disease must, in order to shorten the duration of the affection, be applied within a few hours of its inception. The disease can be aborted, if the term abortion is proper as applied to something which does not already exist, but the germs begin to produce irritation of the epithelium of the urethral mucous membrane very soon after their introduction into the canal, and if the germs be destroyed *in loco*, the disease not having yet fairly begun, it may be said to have been prevented rather than aborted.

In concluding the general consideration of the treatment of urethritis the author takes occasion to impress upon the practitioner the fact that urethral inflammation is very rarely treated upon sound and rational therapeutic principles. Our patients expect more from us, and we expect more from our remedies, than in almost any other disease that could be mentioned. The prevalent notion of the simplicity of gonorrhea and its congeners has proven very disastrous, not only to the laity, but to the over-confident physician. The practitioner should never lose an opportunity to impress upon the mind of the patient the undoubted fact, as supported by clinical observation and laboratory investigation, that gonorrhea is one of the most severe and perhaps *the* most far reaching in its results of all the infectious diseases. It is not only worse than a bad cold, contrary to the lay opinions upon the subject, but it is far worse than its much-dreaded rival for venereal popularity,—syphilis.

Abortive Treatment.—The abortive method of treatment has been generally understood to imply the substitution of a simple for a specific inflammation. This practice is a relic of bygone days, which has impelled surgeons of excellent reputation, and undoubted wisdom in other directions, to rub the pure crayon of nitrate of silver in eyes affected by virulent conjunctivitis. It is even possible that there are surgeons at the present time who advocate

PLATE 2.

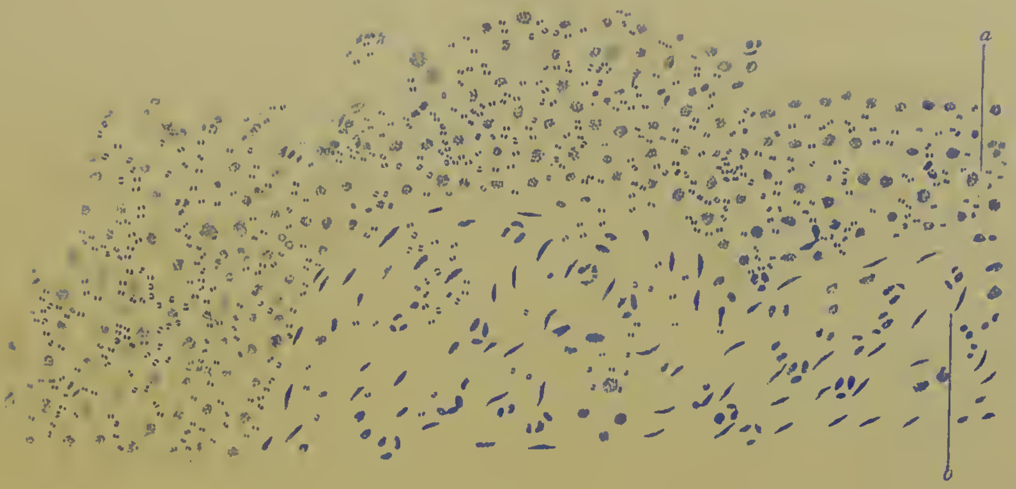

FIG. 1.—Anatomy of acute urethritis: *a*, epithelium infiltrated with pus-cells and gonococci; *b*, pus-cells and gonococci in the connective tissue (Finger).

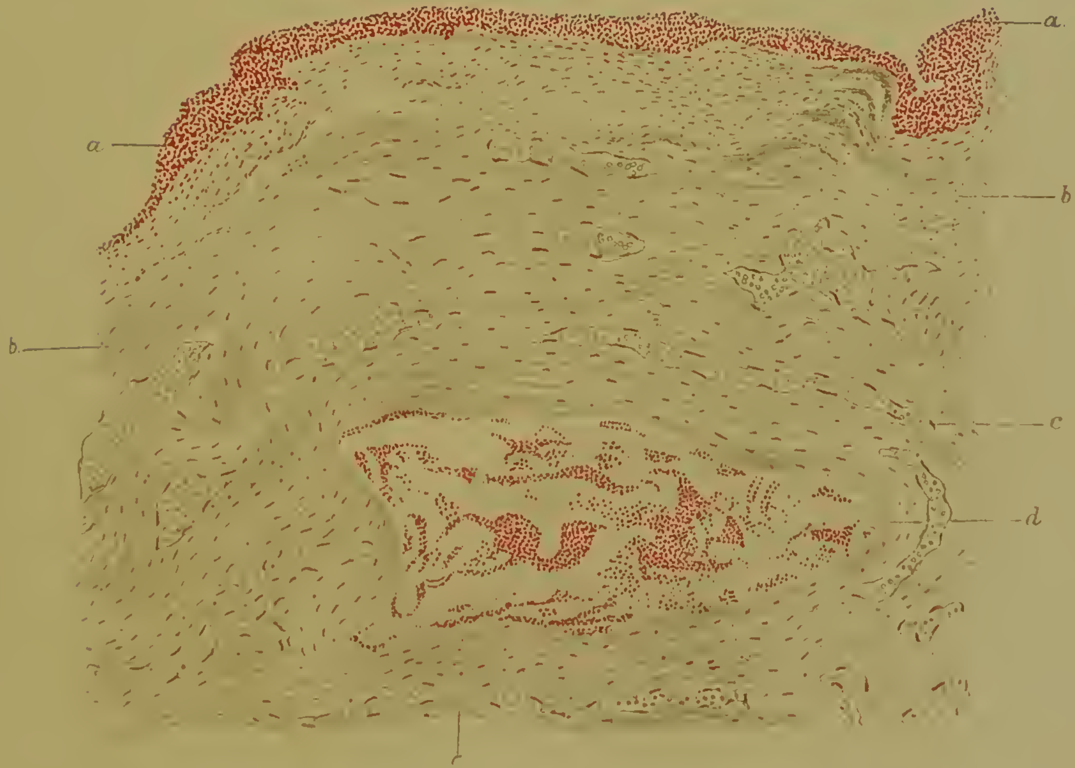

FIG. 2.—Beginning stricture: *a*, many-layered plate epithelium; *b*, shrunken connective tissue; *c*, narrowed cavities of the corpus cavernosum; *d*, remains of a Littré gland, destroyed by periglandular and shrunken connective tissue (Finger).

this method of treatment for this particular disease. During the author's term of service as hospital interne he saw pure nitrate of silver applied on several occasions, and in every instance it was followed, not by the substitution of a simple for a specific inflammation, but by complete destruction of the eye as far as its visual capacity was concerned. The author remembers asking one of the hospital staff who applied this method of treatment in a case of virulent ophthalmia, under the advice of a prominent specialist, how he knew which had destroyed the sight, the disease or the treatment. He replied that it was impossible to say positively, but that it must be the disease, because "they all went that way, anyhow." Arguments are useless as opposed to such logic as this, but it is hoped that it is unnecessary to protest against such pernicious doctrines as applied to the treatment of urethritis.

The abortive method of treatment as applied to urethritis should properly imply, not the fossilized and fallacious idea of the substitution of one type of inflammation for another, but (1) the removal as far as may be of the virulent germs that have been deposited upon the surface of the mucous membrane, and which, although they have begun to manifest their presence by slight irritation of the meatus or just within it, have not yet deeply penetrated into the substance of the mucous membrane and infected the subjacent cells; and (2) the neutralization or destruction of the germs and their products by means of antiseptics or germicides, which in this instance imply all chemical substances capable of destroying or inhibiting the activity of the germs of urethritis without destroying the mucous membrane.

These requirements are the more readily fulfilled because the disease begins at the meatus or, at most, in the fossa navicularis, and gradually affects contiguous areas of mucous membrane. The substance most generally used in the abortive method of treatment is nitrate of silver. This may be used in two ways: (1) By the injection of a mild solution at frequent intervals; (2) by means of a single injection of a comparatively strong solution. If properly done and at an appropriate period in the incipiency of the disease, either one of these methods is usually safe and is not likely to result in stricture—the principal danger of the abortive method. A solution of nitrate of silver, fifteen grains to the ounce, may be thrown into the canal by means of a small drop syringe, which is passed into the urethra for about 2 inches, the fluid being ejected as the syringe is slowly withdrawn. It is held in the urethra for a few seconds, and a weak solution of sodium chloride or bicarbonate is then thrown into the canal, the patient being instructed to urinate immediately thereafter. If this be carefully done when slight discharge and itching at the meatus are first observed, the method is likely to prove successful and is devoid of danger. In lieu of the strong preparation a solution of one-half grain of nitrate of silver to the ounce of water may be used every two hours for twenty-four hours or less, the treatment being stopped as soon as pronounced smarting during micturition develops.

That nitrate of silver is efficacious in destroying the germs of virulent inflammation is shown by the excellent results obtained by Credé in the prophylaxis of ophthalmia neonatorum by the instillation into the eyes of the new-born infant of a 2 per cent. solution. While the use of the nitrate of silver in careless hands is dangerous, the author is satisfied that, if properly used, its dangers are greatly exaggerated. Injections in a strength of thirty grains to the ounce may often be used in chronic urethritis with the best possible results. Such injections, however, should only be given by the deep syringe.

The method that the author prefers for the abortion of urethritis is the prolonged and systematic irrigation of the anterior urethra with a solution of permanganate of potassium in a strength of from 1 in 10,000 to 1 in 5000. This should be used as warm as can be comfortably borne by the patient, and kept up for one-half or three-quarters of an hour at a time, the process being repeated twice daily for three or four days, after which time the treatment should be given once daily for two or three weeks. Care should be taken not to use the water too hot, as destruction of the urethral epithelium may easily be produced: this is a point too often forgotten. The patient may occasionally receive benefit from this same treatment if self-administered by means of the ordinary penis syringe, although irrigation viâ the short nozzle at the hands of the surgeon is best. Long nozzles for irrigation should not be used. The author has found a short nozzle of his own device (Fig. 43) to be the most satisfactory of all the irrigating appliances that he has used. The irrigation should be made by means of the ordinary fountain syringe, care being taken not to have the elevation of the douche-bag too great, as injurious pressure upon the urethral walls may be thereby produced. During the continuation of this treatment the patient should be placed upon the usual internal treatment with alkalies, and suitable restrictions regarding diet and exercise should be imposed. It is sometimes advantageous to combine the internal administration of oil of sandalwood with the irrigation method. The author would especially enjoin caution in the matter of too speedy cessation of treatment. As a rule, no discharge will be noticeable after the first twelve or twenty-four hours; hence it is very often difficult to convince patients of the necessity of several weeks' careful treatment. Experience shows, however, that unless prolonged treatment be instituted the development of the disease will be simply retarded, not aborted.

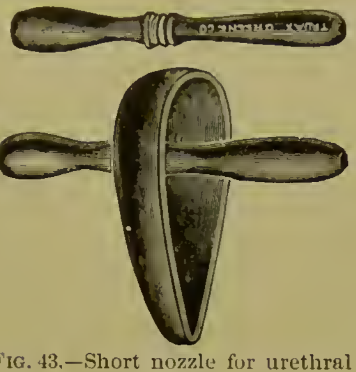

FIG. 43.—Short nozzle for urethral irrigation.

Where it is impossible for the patient to submit to frequent irrigations of the urethra the permanganate of potassium may be used by means of ordinary urethral injections. The patient can tolerate much stronger solutions with this method of administration than where irrigation is employed. It is well to begin with a solution of 1 in 5000, the patient being instructed to use it every two hours in copious quantity, the treatment concluding by filling the urethra full of the solution and holding it in the canal for ten or fifteen minutes. The strength of the permanganate solution can be increased up to 1 in 2000.

Rational or Methodical Treatment.—*General Management.*—The rational method of treatment is of necessity the one that we are most often called upon to prescribe, for the reason that, as a rule, the patient rarely seeks advice until urethritis is well established.

The term "rational" is used in contradistinction to the expectant method of Fournier, Diday, and others, which consists chiefly in the administration of placebos.

In cases of simple urethritis mild measures of treatment may be directly curative, which cannot be said of the virulent type of the disease. Attention to genito-urinary hygiene, regulation of the diet, the administration of mild laxatives, and the use of weak astringent injections usually suffice for the cure of the milder cases within a few days; at least such measures check the discharge. From what has been said of the causes of the simple forms of inflammation of the urethra, it is obvious that in the majority of instances surgical treatment is necessary for a complete cure, either in conjunction with medical treatment or following the cessation of the urethral discharge. Thus dilatation or cutting operations are required for stricture; the contracted meatus must be cut, and congested and granular patches must be stimulated to repair by means of applications through the endoscope, or other measures applicable to the treatment of certain forms of chronic gleet must be instituted.

So intimately connected are simple urethritis and chronic pathological conditions of the canal that it is unnecessary to discuss further at this point the treatment of what must obviously be in the majority of instances merely a symptom.

The most important principle in the management of severe urethritis is the maintenance of physical and sexual rest. It is an unfortunate circumstance that individuals with gonorrhea labor under the fatuous idea that the disease is in itself not a serious one, and it is consequently difficult, indeed it is impossible in the majority of cases, to induce them to take complete rest. They wish to be cured promptly, but upon entirely different principles from those that govern the management of other acute inflammatory affections. A man with a sharp attack of urethritis is certainly very sick, yet how seldom can he be induced to take to his bed and be treated upon the same rational principles that are carried out in other inflammations! A man with a fractured limb is of necessity compelled to rest, and, independently of the mechanical obstacle to movement, it is not difficult to convince him that absolute quiet is necessary for cure. There is little or no danger in a simple fracture, yet the patient is perfectly tractable. There is great danger, usually, in cases of virulent urethritis, yet it is seldom possible to convince the patient that quiet is necessary. A moment's reflection will convince the practical clinician of the truth of the assertion that there are few diseases indeed which are characterized by so many and such severe pathological possibilities as is that under consideration.

It needs but a casual survey of the morbid possibilities of urethritis to convince one that it is a serious affection. It is an undeniable fact that gonorrhea is the most dangerous of the venereal diseases, for through the medium of its sequelæ and complications the disease is the cause of more deaths than can be justly attributed to the direct or indirect influence of syphilis. By comparison, chancroid is essentially a benign disease. Subtract the evil effects of gonorrhea from the list of human ills, and the resulting increase in the longevity and happiness of the race would be something marvellous.

It is the author's belief that every patient with a severe urethritis should be confined to his bed for from one to two weeks or more, and that, if this could be accomplished, the majority of cases would not only be subdued within two or three weeks, but stricture and other complications and sequelæ would be almost unheard of, providing the medical and surgical treatment adopted in conjunction with rest were not in itself productive of injury. In the comparatively few instances in which the author has been able to carry out this plan the results have invariably substantiated this opinion. Sexual rest is a positive necessity, and it is hardly necessary to state that this implies both mental and physical sexual repose. The mind must be kept free from sexual impressions and ideas of all kinds.

Second only in importance to rest is attention to diet. A restricted regimen is necessary, not only because of its beneficial effects from an antiphlogistic standpoint, but for the purpose of limiting the waste products excreted by the urine. It is upon the amount and character of these waste products that the irritating properties of the urine depend, and there is nothing so efficacious in diminishing its acridity as attention to diet, the ideal regimen being bread and milk. Stimulants, such as alcoholics of all kinds, tea, and coffee, should be interdicted. The more closely a vegetable diet is adhered to the better, providing a bread-and-milk regimen be not acceptable. Asparagus and tomatoes, however, are to be avoided.

It is not considered necessary by the majority of surgeons to restrict the patient in the manner of indulgence in tobacco. Chewing is probably not injurious, but this cannot be said of smoking. Practical observation shows that smoking, unless in extreme moderation, is decidedly inimical to the cure of inflammatory troubles of the genito-urinary tract. It is well, therefore, to prohibit it as a matter of routine. Tobacco in excess certainly makes the nervous system irritable and tends to promote sexual excitability. The evil influence of smoking upon the mucous membranes is probably not limited to those of the nose and throat, but also extends to all the mucous tracts of the body through the constitutional effects of the weed.

The alkaline mineral waters should be given for the purpose of diluting and increasing the bulk of the urine. To these mineral waters may be added potassium citrate, acetate, or bicarbonate, with the object of still further lessening the irritating properties of the urine by neutralizing its acidity. Profuse diuresis, providing the urine is bland and non-irritating, is highly desirable, for the urethra is like an infected wound in a certain sense, and requires frequent irrigation for the purpose of cleansing the infected surfaces.

Cleanliness is absolutely essential, and individuals with a long prepuce should be particularly cautioned to cleanse the parts beneath it thoroughly, and, if possible, to retract it and bathe the glans several times daily, to prevent balanitis and further cultivation of the products of virulent inflammation.

Some attention is necessary to the dressing of the penis. One of the most pernicious practices that can be adopted is to bind absorbent cotton or other material over the meatus—a plan that is frequently followed by patients with a long prepuce, in the orifice of which absorbent cotton or lint can be packed with great facility. Common sense should teach the surgeon that, inasmuch as the inflammation of the urethra is due to the inoculation of successive areas of the mucous membrane with the virulent products of inflammation, the process extending gradually from the anterior to the deeper portions of the urethra, any dressing which dams back the discharge must necessarily feed the pathological process and enhance the danger of its extension into the deeper portions of the canal. Improper dressing is frequently the cause of serious complications. A very simple plan is for the patient to roll the shirt up in front out of harm's way and to pin upon the tail of that garment a soft white handkerchief or napkin, which is drawn through beneath the perineum and up over the penis in such a manner that one corner of the napkin may be tucked down each leg of the trousers, with numerous folds of the soft cloth resting in the crotch of that garment in such a way that the penis rests therein, the meatus at the same time being unobstructed. Another very excellent plan is to pin the toe of a stocking upon the drawers in such a manner that the penis may hang therein, without the meatus coming in contact with the improvised bag. In the bottom of this receptacle a little absorbent cotton may be placed and frequently changed. There are several cloth gonorrhea-bags upon the market that answer the same purpose. The penis should never be dressed and allowed to remain in the upright position. By attention to these little details cleanliness may be secured, and at the same time free drainage of the affected membrane facilitated. Rubber protectives should never be used.

Inasmuch as it is impossible for us to abort the inflammation when it has already frankly begun, it is obvious that we must content ourselves with a not too officious management of the case until the normal process of repair begins.

One of the best measures for facilitating resolution of inflammation is the application of heat, and it is nowhere more efficacious, if properly applied, than in inflammations about the sexual apparatus. It will be found that heat applied by means of the sitz-bath of from a half to one hour's duration several times daily will materially assist in the successful management of urethritis, particularly if there exists any irritation about the prostate or neck of the bladder. When the patient will consent to keep perfectly quiet, it is the most valuable auxiliary method of treatment at our command. The value of the hot sitz-bath has been questioned, but the author is convinced of its efficacy.

In lieu of the general application of heat by means of the bath, prolonged soaking of the penis in hot water will be found to be beneficial. When urination is very painful, relief may be obtained by passing the urine while the organ is immersed in a vessel of hot water. The use of remedies, both internal and local, should be guided not only by a knowledge of the natural course of the disease, but by the conditions present at various stages of the affection in each individual patient. It would be absurd as well as pernicious to treat a case complicated in the stationary stage by inflammation of the bladder or prostate in the routine fashion prescribed for the average uncomplicated case at the same period of the disease.

Internal Medication.—The range of application of internal medicaments in acute urethritis is not very extensive, the so-called specific remedies being especially limited in number. During the increasing stage of the disease there is sometimes considerable fever, and the tincture of aconite or veratrum viride will be found to be useful. The author believes that these remedies are not used sufficiently often.

Alkaline diluents should be given throughout the course of the disease, either alone or in combination with other drugs. The fluid extract of pichi (*Fabiana imbricata*) appears to have an excellent effect in lessening the irritating properties of the urine and soothing the inflamed mucous membrane. Combinations of buchu, slippery elm, uva ursi, linseed, etc. are all beneficial, especially if given in infusions, their action in this disease being essentially the same as in inflammation of the bladder. The ergot of rye and the ergot of corn (*Ustilago maidis*) have been recommended as exerting a specific effect upon the disease. In the early stages of the affection ergot does not seem to be of any particular service, and, moreover, is very disagreeable to take. In the later stages of the affection, however, it undoubtedly exerts an astringent influence upon the inflamed surface, and may be given in quite liberal doses, with marked benefit in some cases.

The fluid extract of corn silk (*Stigmata maidis*), in doses of one dram every two or three hours, has been highly recommended in the treatment of the acute stage of gonorrhea. The author has failed to notice any special benefit derived from this remedy in acute gonorrhea. It has, however, seemed to be beneficial in some cases of catarrhal gleet.

It is desirable to administer some anaphrodisiac during the height of the disease for the purpose of allaying sexual excitement and producing a direct sedative influence upon the inflamed part. A dose of twenty to sixty grains of potassium bromide at bed-time has usually the desired effect. If a more powerful effect is desired, the following mixture will be found serviceable:

℞. Fl. ext. ergotæ,	♏xv;
Tr. gelsemii,	♏v;
Potassii bromidi,	gr. xx;
Tr. hyoscyami,	♏xxx;
Syr. aurantii,	q. s. ad ℥ss.—M.

Sig. At bed-time.

The following is also serviceable:

℞. Chloralis hyd.,	gr. v;
Tr. aconiti rad.,	♏iij;
Sodii bromidi,	gr. xv;
Aq. camphoræ,	q. s. ad ℥ss.—M.

Sig. At bed-time.

Either of these combinations will usually allay sexual excitability and prevent or relieve severe chordee. It may be necessary, however, in some cases in which erections are painful and troublesome to administer an opiate. Opium has a certain degree of stimulating effect upon the sexual organs that rather detracts from its efficacy as an anodyne in these cases. This objectionable feature may be avoided by combining the deodorized tincture of opium in moderate doses with either chloral or potassium bromide. Where these various remedies prove unsuccessful the cold-water coil will invariably afford relief, and has in addition a decidedly beneficial effect upon the inflammation. If the patient sleeps on a hard bed, with a knotted towel applied about his waist in such a manner that he cannot comfortably lie upon his back, painful erections are not so apt to occur.

Morphine is sometimes necessary, and is best given by suppository, alone or in the following useful combination:

℞. Morph. sulph.,	gr. $\frac{1}{12}$;
Ext. hyoscyami,	gr. $\frac{1}{2}$;
Camphor. monobromidi,	gr. v.—M.

Ft. suppos. No. 1.
Sig. At bed-time.

The remedies most relied upon in the treatment of gonorrhea are the various balsamic preparations. These should not usually be given during the increasing stage of the disease, and it would seem that more benefit is to be derived from them when they are not used early. There is, perhaps, no objection to the administration of oil of sandalwood in the increasing stage; cubebs and copaiba, however, are more stimulating, and consequently inadvisable at this time. Sandalwood oil is best administered in the form of capsules containing from ten to fifteen minims. Of these from four to ten may be given daily. In lieu of the capsules the pure oil may be given in doses of ten to fifteen drops upon a lump of sugar, this dose being repeated four or five times daily. The limit of tolerance is usually indicated by stomachic disturbance or quite frequently by pain in the back resembling lumbago, this being probably nephralgia dependent upon over-stimulation and consequent irritation of the kidneys. Sandalwood is much more likely to produce this result than are copaiba and cubebs. During the stationary and declining stages copaiba and cubebs may be given alone or in combination. Of these two drugs, cubebs is most stimulating to the mucous membrane of the urethra, but least irritating to the stomach. Copaiba occasionally exerts an unpleasant effect in the form of an efflorescence or rash upon the skin, which is sometimes so pronounced as to simulate measles. The cause of this action of copaiba is not known. It would appear, however, that the eruption is produced through the medium of idiosyncrasy, an impression being made by the drug upon the sympathetic nervous system analogous to that produced in some individuals by the ingestion of shellfish, overripe tomatoes, etc. Quinine and several other drugs have been observed to produce a similar reaction of the skin, probably in the same way. It is possible that defective renal elimination and vicarious skin action have something to do with these cases.

Cubebs and copaiba may be given in doses of ten to twenty drops of the oil four or five times daily, either in capsules or in the form of an emulsion. The author prefers the emulsion where the patient does not object to its taste. The doses of the balsams may be increased to the limit of tolerance, but it is wise not to give them too liberally until the disease begins to decline. There are no better combinations in the way of balsamic emulsions than the following:

℞. Liq. potassii,	ʒj;
Bals. copaibæ,	℥j;
Ol. gaultheriæ,	♏x;
Ext. glycyrrhizæ fl.,	℥ss;
Saccharin.,	q. s.;
Muc. acaciæ,	q. s. ad ℥iv.

Sig. A teaspoonful every two or three hours.

℞. Ol. cinnamomi,	♏x;
Ol. cubebæ,	
Sp. æther. nit.,	*āā*. ℥ss;
Muc. acaciæ,	q. s. ad ℥viij.—M.

Sig. A tablespoonful three or four times daily.

Cubebs may be given in powder in doses of one drachm two or three times daily. This method of administration sometimes agrees with the stomach very much better than either the emulsion or capsule. The formulæ given are more or less illustrative, and may be varied according to the judgment of the practitioner. Vidal advocates the use of gurjun balsam in doses of two grams before each meal. Dr. R. W. Taylor speaks favorably of the tincture of cannabis sativa in doses of ten to fifteen drops in water three or four times daily.

In the later stages of gonorrhea, in which there is a tendency to chronicity, turpentine is occasionally of value, the white or Canada turpentine being the best variety. The author has obtained benefit in some cases from the administration of the following:

℞. Terebinth. alb.,	ʒj;
Res. podoph.,	gr. ss;
Camphor. monobromidi,	ʒj.—M.

Ft. pil. No. 30.
Sig. One pill four times a day.

In some instances in which the patient is debilitated the addition of iron to the balsamic preparations is advisable for its tonic and astringent effect. Matico and other vegetable preparations containing tannin are recommended for internal administration, but the author has failed to note any benefit from these drugs, with the possible exception of hydrastis canadensis, which has seemed to be of service in some cases of chronic urethritis.

The beneficial effect of the balsams when administered internally is rather peculiar, inasmuch as when locally applied by means of injections they have apparently no action whatever. It would appear that in their passage through the digestive tract and circulation they undergo some chemical change by virtue of which they exert a special soothing effect upon the inflamed mucous membrane. That they exert any specific (microbicidal) influence over the poison of virulent urethritis is highly improbable. Their effect is certainly not constitutional, as they are of absolutely no service in gonorrhea in the female unless the urethra is involved.

The local use of copaiba in its natural state does not seem to be beneficial. As a matter of curiosity, however, it may be mentioned that it has been recommended for local use in vaginitis. M. Baratier[1] recommends the use of copaiba in the form of vaginal suppositories for gonorrhea in the female, these suppositories containing also the extract of opium. Inasmuch as this drug is said to cure "in about twenty days," it is hardly necessary to comment upon it as a means of specific medication, for certainly a remedy which will not bring about a cure in less time than this can hardly be said to be very efficacious as a specific.

Raquin of Paris has prepared a solution termed by him copaibate of soda, which is said to be useful as an injection as well as internally. Salol and eucalyptus in combination are often very serviceable for internal administration in urethritis. Salol should be given in doses of from ten to twenty grains three or four times a day, the eucalyptus being administered in combination with it in doses of ten minims. The benzoate of soda often acts better than other preparations of the alkalies.

Aperient medicines are beneficial throughout the course of urethritis, particularly during the acute stage. The saline laxatives are especially beneficial, the various natural mineral waters, notably the Apenta water, being the best of these. The Carlsbad salts are also of service. It should be remarked in this connection that constipation is invariably attended with more or less congestion of the prostate and urethra, and its correction is therefore desirable. Bruising of the prostate during a difficult stool may constitute the point of departure for prostatic complications in the course of acute urethritis.

Naphthol is a remedy recently recommended in urethritis. This agent is claimed to act by becoming decomposed and thereby converted into some modification of phenol (or carbolic acid), which, coming in contact with the mucous membrane of the genito-urinary tract, is supposed to destroy the germs of the disease. It has been given in doses of from two or three to fifteen grains several times daily; it would appear to be indicated in chronic vesical inflammations rather than in urethral troubles, inasmuch as it probably makes the urine less putrescible. It is apt to disturb the stomach, and, as the process in gonorrhea is an active mixed infection rather than a septic process, the writer cannot appreciate its advantages over some other drugs.

Local Medication.—Local medication in acute urethritis is best accomplished by means of injections.

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[1] *Thèse de Paris.*

A great deal of discussion has been evoked regarding the advisability of the injection method of treatment in gonorrhea. There is a deep-grounded—and in many instances, it must be confessed, justifiable—prejudice against its use entertained by the laity, and incidentally by some surgeons. It is supposed by many that the injection method is usually responsible for stricture and other untoward complications and sequelæ of urethritis. While this prejudice is undoubtedly founded upon a substantial basis in some instances, the author ventures to assert that it is the abuse, and not the use, of injections that is responsible for their unpleasant results. Injections of simple water, if improperly used, may produce injury, and it is certainly true that strong astringent or antiseptic drugs will, as a rule, produce unpleasant results. Any injection of a strength sufficient to produce severe pain is probably strong enough to destroy the already partially devitalized epithelium upon the surface of the mucous membrane, and as a consequence there must necessarily occur at various points localization and intensification of the inflammatory process. Given at the proper time and in the proper manner and strength, injections are not only harmless, but very beneficial, and really prophylactic of stricture and other complications by limiting the severity and duration of the inflammatory process. Any form of injection that is given for the purpose of cutting short the disease during the height of the inflammation is apt to produce injurious results. It is an unfortunate fact that many surgeons have joined in the popular prejudice against injections; as a consequence, nearly every patient who has stricture resulting from a gonorrhea that has been treated by the injection method, no matter how skilfully and beneficially, attributes the permanent injury of the canal to the treatment of his urethritis, and should he consult a surgeon of anti-injection proclivities, he is certain to have his erroneous ideas confirmed, much to the detriment of the reputation of his former surgeon, who perhaps treated his urethritis upon strictly scientific and conservative principles.

One of the most important points in connection with the injection method of treatment is the selection of an appropriate syringe. The ordinary glass syringe or the hard-rubber syringe with a long nozzle is perhaps responsible for more prolonged cases of urethritis than anything that could be mentioned. The introduction of such instruments, even when performed very carefully, invariably excites more or less mechanical irritation, and it is not unusual to detect in long-standing cases a congested and granular patch of mucous membrane precisely at the spot upon which the nozzle of the syringe impinges during injection. Very few surgeons devote much attention to the instruction of the patient in the proper use of the syringe or to the selection of an appropriate form of this instrument. The author has seen not a few cases of chronic urethritis that subsided immediately upon the cessation of the use of faulty syringes. In some cases a cure will result from the use, with a proper syringe, of the same astringent solutions which have failed to produce any effect whatever when injected with one of the long-nozzled abominations. The best form of syringe is that with a conical point, known as the "Excelsior P." The instrument must be of moderate capacity in order to accomplish any benefit. If it does not contain sufficient fluid thoroughly to distend the urethra when thrown into the canal with a moderate degree of force, the medicament is never brought in contact with the entire diseased surface. In using the syringe the patient should be instructed to urinate first, and thus clear away the purulent secretion as far as possible, and then to inject the fluid slowly and steadily into the canal. Too great or spasmodic force is liable to drive the fluid—and with it germ-infection

—into the deep urethra and produce prostatic, vesical, or testicular complications.

During the increasing stage of urethritis injections, if used at all, should be very mild; they may usually with advantage be dispensed with altogether at this time. A solution of mercury bichloride in a strength of from 1 : 30,000 to 1 : 15,000, in combination with a small amount of glycerin, is about the best routine injection for use at this period. Some cases appear to be materially benefited by it, but in many it will be found to be too irritating and, temporarily at least, harmful. Even in the cases in which it is beneficial it appears to lose its effect in from two or three to ten days, and it becomes necessary to substitute for it some of the ordinary astringents in mild solution. It is possible that its evil effects are due to a peculiarly destructive influence upon the epithelium. It is always more markedly beneficial in simple than in virulent urethritis.

It has sometimes occurred to the author that astringents often serve to prevent the normal evolution of urethritis by condensing the tissues and sealing up, so to speak, the avenues of germ-elimination.

In lieu of the bichloride injection during the increasing stage an anodyne injection may be given, the following being useful formulæ:

℞. Atropinæ sulph.,	gr. ij ;
Bismuthi subnit.,	ʒiv ;
Muc. acaciæ,	
Aquæ dest.,	*āā.* ℥ij.—M.

Sig. Shake well, and inject three times daily.

℞. Tr. opii deod.,	ij ;
Bismuthi subnit.,	iv ;
Muc. acaciæ,	
Aquæ dest.,	*āā.* ℥ij.—M.

Sig. Shake well, and inject three times daily.

℞. Morph. sulph.,	gr. viij ;
Cocainæ,	gr. iv ;
Muc. acaciæ,	℥j ;
Aquæ dest.,	q. s. ad ℥ij.—M.

Sig. Inject three times daily.

There is no objection to the use of a mild and sedative astringent in combination with the anodynes:

℞. Plumbi acetatis,	gr. iv ;
Vini opii,	ʒij ;
Aquæ rosæ,	q. s. ad ʒiv.—M.

Sig. Inject three times daily.

℞. Sodii biboratis,	gr. xx ;
Morph. sulph.,	gr. vj ;
Aquæ rosæ,	℥iv.—M.

Sig. Inject three times daily.

In the stationary stage of the affection the strength of the astringent injections may be slightly increased. It would appear that it is not so much the form of astringent as the method of its use that determines the beneficial effects. It will be found that a number of different astringents will give about the same average results when properly used, although in some cases it will be found necessary to vary them. The most popular astringent drug is the sulphate of zinc, and this will be found beneficial in quite a large proportion of cases. The author prefers the sulphocarbolate or iodide of zinc to the sulphate. The nitrate of silver in the strength of one-eighth to one-half of a grain to the ounce of water is often of great service. Some recommend it as the best routine injection.

The following illustrative combinations will be found to be useful :

℞. Zinci sulphat. (acetat.),	gr. xij ;
Morph. sulph.,	gr. x ;
Glycerini,	℥j ;
Aquæ rosæ,	℥iij.—M.

Sig. Injection.

℞. Zinci sulphocarb.,	gr. xvj ;
Glycerini,	℥j ;
Aquæ rosæ,	℥iij.—M.

Sig. Injection.

℞. Zinci iodidi,	gr. viij ;
Ac. carbol.,	gr. iv ;
Aquæ dest.,	℥iv.—M.

Sig. Injection.

The acetate of lead is also a serviceable astringent :

℞. Plumbi acet.,	gr. xx ;
Tr. opii,	ʒij ;
Aquæ rosæ,	q. s. ad ℥iv.—M.

Sig. Injection.

The vegetable astringents are often to be preferred to the mineral. Matico, hydrastis, catechu, kino, and like drugs are very popular, and are dependent upon the tannic acid which they contain. The muriate of hydrastin is especially popular and very often efficacious. A favorite vegetable astringent in the author's practice is the fluid extract of hamamelis virginica. The following formula has proved of great service :

℞. Hydrastin. mur.,	gr. x ;
Ext. hamamelis fl.,	ʒij ;
Glycerini,	ʒj ;
Aquæ dest.,	q. s. ad ℥iv.—M.

Sig. Injection.

As the inflammation begins to decline the strength of the injection selected may be increased, sometimes to double the proportions given. This should be done very cautiously, however, and in no instance should an injection be continued when it is found to produce considerable pain. Nothing more than slight smarting is warrantable. In some cases the use of the injection does not produce much immediate discomfort, but it is found that smarting during micturition increases. Under such circumstances either the strength of the injection should be diminished or some other form of medicament substituted for it. This proposition is especially pertinent as applied to injection of the mercury bichloride: it will be found that with this drug in a strength of even one-sixteenth of a grain to the ounce patients will complain in a day or two, not of pain following the injection, but of severe smarting in micturition.

Sulphate of thallin is often of service in a strength of 20 grains to the ounce of rose-water.

Iodoform has been used to a considerable extent in the treatment of acute urethritis, but, as far as the author's experience goes, it does not seem to be superior to, or even as efficacious as, many other drugs, and its disagreeable odor more than counterbalances any possible beneficial effects. In the chronic forms of the disease, however, it may be used with advantage if the patient can be induced to disregard its telltale odor.

A form of treatment that has been highly recommended is the insertion of soluble bougies of various types of medication. The author is satisfied that this method of treatment is not only illogical, but is very injurious in acute urethritis, for any suppository of sufficient stiffness to permit of its introduction into the urethra is capable of producing mechanical irritation. As an additional objection there is no form of soluble bougie that can be practically applied by the majority of patients. There exists, also, the not inconsiderable danger of exciting inflammation of the deep urethra. The author has seen in consultation a number of cases of prostatic and vesical complications which he has been inclined to attribute to the use of the bougies, and in experimenting with them in his own practice he has had on several occasions unfortunate results. It is certain that it is impracticable to combine germicide drugs with the bougies in sufficient strength completely to destroy the germs of the disease, and, inasmuch as the bougie necessarily carries with it more or less secretion into the deeper portion of the canal, it is obvious that an extension of inflammation is apt to result. The author does not wish to be understood as absolutely condemning the use of soluble bougies, for in the chronic forms of urethritis they are often of service. It must be confessed, however, that even in these cases the bougie is of benefit chiefly through a primary increase of irritation of the canal as a consequence of the mechanical stimulation it produces. The author, therefore, rarely uses them, excepting in exceedingly chronic cases in which he considers it necessary to "wake up," so to speak, the inactive mucous membrane.

One of the most popular modern methods of treatment of urethritis is that by retro-injection of hot water or antiseptic solutions through a soft-rubber catheter or some of the various forms of tubes devised specially for this purpose. Many of those who have tried this method are very enthusiastic in its praises, but the author is free to say that these surgeons must either have a knack in the application of the method which he has been unable to acquire or his patients are characterized by very sensitive urethræ. The method is open to the same objections as the use of soluble bougies, for in the introduction of the tube infection is carried into the deeper portions of the canal, and it is questionable whether the injection fluid can be safely given in a strength sufficient to neutralize it. More or less mechanical irritation is produced, and in very acute cases this is likely to be a serious matter. On the other hand, in certain cases that exhibit a tendency to chronicity the retro-irrigation method is decidedly beneficial.

The author has found that a soft, open-ended catheter is as useful as anything for deep irrigation of the urethra. Under ordinary circumstances, and always in acute cases, a short nozzle is sufficient. This is to be used without a urethral tube, and has a concave shield to catch the return flow. There are several varieties of injection-tubes that are more or less useful.

A late fad in the treatment of urethritis is what is termed the dry method. This consists in the introduction of dry antiseptic powders into the canal through a special and patented device. This method is open to the same objections as is the use of soluble bougies and retro-irrigation in acute gonorrhea. It is apt to be of service, however, in less acute forms of the disease.

Blistering the perineum and penis by means of cantharidal solution is a favorable remedy for acute gonorrhea with some surgeons. Milton, in particular, favors this method of treatment, but applies the blister in the form of cantharidal plaster wrapped about the penis. The author has found that most patients object to fly-blisters, and has compromised by applications of the tincture of iodine along the course of the urethra with apparent benefit. Milton recommends what he terms a "caustic plug" in the treatment of obstinate cases of gonorrhea. This consists in a strip of linen, saturated in a five-grain solution of nitrate of silver, which is inserted into the urethra through a tube similar to an endoscope; the latter is then removed, the cloth being allowed to remain until it comes away with the urine.

It is not the writer's purpose to present all of the various methods of treatment and specifics that have been recommended for urethritis. This would be an onerous as well as unprofitable task. The list of specifics recommended runs well into the hundreds. The foregoing is intended only as a practical outline of urethral therapeutics.

CHRONIC URETHRITIS.

Chronic urethritis embraces all those various phases of secretion-forming inflammations of the urethra which are generally included under the generic term of gleet. For the sake of accuracy the latter term, if it be used at all, should be applied with the understanding that it merely implies a symptom, and only to those chronic forms of inflammation which come on, at a greater or less interval, after the acute urethritis is apparently cured, as a consequence of various pathological changes of a chronic character due to the antecedent acute inflammation. It is better, however, to use the term first suggested.

Causes.—The causes of chronic urethritis are as follows:

1. Idiosyncrasy. This consists in this instance of a predisposition to mucous fluxes and catarrhs characterizing certain individuals. This is a particularly important factor in certain climates. The variable temperature and barometric pressure characterizing our Lake region are an illustration of this, and seem to have an influence in aggravating and perpetuating urethritis.
2. The gouty and rheumatic diatheses.
3. Dyscrasiæ of various kinds, particularly syphilis.
4. Cachectic conditions resulting from various constitutional diseases of an acute or chronic character.
5. Intemperance in eating and drinking.
6. Improper treatment, involving usually the use of too powerful injections, with resultant destruction of the epithelium of the mucous membrane.
7. Too active exercise during the acute stage of urethritis.
8. Prolonged and ungratified sexual desire.
9. Sexual excesses and masturbation.
10. Privations of various kinds and unhealthy hygienic surroundings.

11. Localization of the acute inflammation at some particular point, with a consequent patch of local disease involving stricture or a granular and congested condition of the mucous membrane. This is the most important factor of all.

It will be observed from a survey of these various causes that the influences which tend to the perpetuation of urethritis are numerous and varied.

Varieties.—Chronic urethritis presents itself under three different forms:

1. The acute inflammation subsides to a certain extent, but remains subacute, with occasional acute exacerbations accompanied by a thick, purulent discharge for an indefinite period. In this form of chronic inflammation there is continual discomfort, with more or less pain and smarting on urination. Generally, too, the prostate is involved to a certain extent, giving rise to a feeling of fulness and tension in the perineum, with frequent urination.

2. The discharge becomes thin and watery, being sometimes so scanty that nothing is visible save a drop or two of muco-purulent fluid escaping from the meatus in the morning. This is the most frequent form of the disease, and is not usually attended by discomfort. It may depend upon—(*a*) A simple catarrhal condition of the mucous membrane, such cases involving the element of constitutional and local predisposition; (*b*) Congested and granular patches in the mucous membrane; (*c*) Organic stricture; (*d*) Urethral polypi and papillomata. These are very rare conditions, but cases in which polypoid growths were removed through the endoscope are reported by Grünfeld and others. The author has operated several times for urethral papillomata with a resulting cure of obstinate gleet. (*e*) Abscesses or fistulæ resulting from acute urethritis, and becoming chronic; (*f*) Dilatation and pocketing, with chronic inflammation of the lacuna magna; (*g*) Urethro-prostatic catarrh; (*h*) Posterior urethritis—*i. e.* chronic follicular prostatitis; (*i*) Folliculitis; (*j*) Cowperitis; (*k*) Tubercular infection.

3. In this form of chronic urethritis the inflammation is apparently recovered from, but after a variable period of time, during which possibly the individual does not have his attention called to his urethra, there develops, as a consequence of sexual excesses, intemperance, or the like, a thin muco-purulent discharge.

The distinctive features of the various phases of chronic urethritis are dependent upon differences in the degree of activity of the inflammatory process: such differences do not warrant a distinct differentiation of chronic urethritis and gleet. As a rule, however, the danger of contagion is directly proportionate to the degree of purulency of the discharge. It must, however, be considered in this connection that it is possible that the discharge of gonococcal urethritis may lose its purulent and ordinary infectious qualities as far as its capacity for imparting acute vaginitis is concerned, but may nevertheless become transformed in such a manner that it is still capable of setting up various uterine, periuterine, salpingian, and ovarian troubles in the female.

Some of the cases of so-called gleet consist in the appearance, under sexual excitement, and almost uniformly on rising in the morning, of a slight, sticky moisture at the meatus. In most of these cases the annoyance produced by the disease is entirely of a mental character. The author is sometimes inclined to think that such patients would experience a feeling of disappointment if they failed to detect on rising in the morning the usual tear of urethral secretion. The appellation of psychic gleet, although a little far-fetched, would not be inappropriate as applied to such cases. Some of these patients are unable to detect the secretion, except on squeezing the urethra. The pertinacity with which such individuals will vigorously "milk" the urethra for the purpose of exhibiting a drop or two of mucus as an evidence of their alleged deplorable condition is worthy of a better cause. Probably 50 per cent. of these cases are kept up by this pernicious practice. Most individuals, upon being questioned, will acknowledge that they are in the habit of seeking for the discharge a number of times daily, and they are considerably surprised when informed that their enthusiastic search for something they do not wish to find is mainly responsible for their woes. The pathological condition in this variety of gleet is simple hypersecretion of mucus by the follicles of the urethra. The author is convinced, moreover, that quite a proportion of cases in which the discharge is more pronounced are dependent upon a catarrhal state of the mucous membrane, with a coincidental hypersecretion of mucus, as a result (1) of habitual overstimulation of the glands and (2) of their enlargement.

The discharge in most cases is thin, rather watery, and of a whitish color. It becomes thick and yellowish, however, under the influence of the various causes enumerated as productive of chronic urethritis. A patient suffering with gleet is continually liable to acute exacerbations of his urethral difficulty upon the occurrence of the slightest exciting cause. The origin of the discharge is the numerous mucous follicles lining that portion of the urethra corresponding to the site of the chronic inflammation. There is more or less epithelium mingled with the discharge, and it will be found that one of the characteristic features of gleet is a rapid formation and removal of the delicate epithelial cells lining the urethra. This is particularly pertinent as applied to those cases of chronic inflammation dependent upon chemical or traumatic interference with the canal, such as is afforded by strong injections and injudicious instrumentation. When congested, granular, or abraded patches exist, there is a constant hypersecretion of mucus or muco-pus, with exfoliation of the epithelium upon the surface of the lesion. In this condition, as well as in stricture, the current of urine, as it passes over the diseased portion of the canal, rolls up into strings or threads the desquamated epithe-

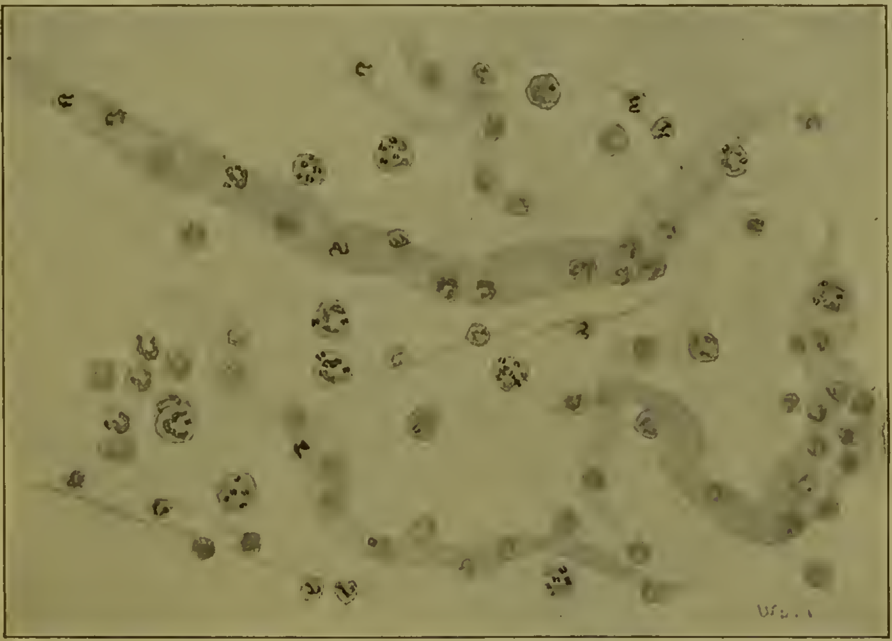

FIG. 44.—Pus taken from an old case of gleet with a recent reinfection, showing old threads and pus-cells with gonococci (Wood).

lium and muco-purulent deposit upon the surface of the diseased membrane. These strings appear in the urine as the delicate thready filaments—*tripperfäden* (Fig. 44)—which, as every practical surgeon is well aware, are invariably indicative of urethral disease. The majority of surgeons attribute this appearance of the urine to stricture, but this is a mistake, for it will be found in many cases in which stricture cannot be detected, being dependent upon urethral catarrh and general desquamation of epithelium. In stricture a condition of chronic inflammation exists posterior to the narrowing of the canal: as a result of obstruction at this point there is more or less pouching of the urethra at the posterior surface of the stricture. This dilated portion of the canal loses its elasticity and contractility, and, as a consequence, forms a more or less passive pouch upon its floor, in which a drop or two of urine almost invariably remains and decomposes. As a consequence of this decomposition the inflammation and consequent muco-purulent secretion are enhanced. It is from this point that the gleety discharge and thready urinary filaments characterizing stricture are derived.

The author desires to emphasize particularly the influence of powerful injections in the production of chronic urethritis. The obstinacy of some cases is undoubtedly dependent upon chemical destruction of the epithelium lining the canal. This, being repeated from day to day, eventually results in a permanently abraded condition of the entire mucous membrane, that necessitates the rapid proliferation of epithelium for the purpose of repair; this epithelium being, however, of a low grade, and, moreover, governed to a certain extent by the influence of physiological habit, is thrown off as rapidly as formed, and as a result the canal remains in a perpetually raw and inflamed condition. It is by no means necessary that to accomplish this untoward result injections should be acutely painful when used.

Still more important factors in the production of chronic urethritis are intemperance and faulty sexual hygiene. The use of alcohol predisposes all of the tissues of the body to inflammatory processes, this being particularly true of the mucous membranes, which become highly irritable; it has, moreover, a special effect in over-stimulation of the sexual apparatus, both through the medium of the nervous system and more directly by the production of irritating properties in the urine. The majority of individuals contracting urethritis are more disturbed by the interruption of their customary fornication than by any immediate or remote danger or inconvenience produced by the disease. They are possessed also with the fatuous idea that any form of sexual stimulation short of actual intercourse is not injurious; as a consequence, they associate intimately with women of loose character, whom they can caress and take liberties with, and, as a result, keep the sexual system in a constant state of excitement. This is fully as disastrous in its effects as natural sexual indulgence, if, indeed, it is not worse. As soon as our patients are satisfied that a discharge no longer exists, or in many instances as soon as the discharge has greatly diminished in quantity, they begin their sexual indulgences. They come to us in the fault-finding manner of the average venereal patient, and ascribe the unfavorable progress of the urethritis to improper treatment; seldom will they acknowledge sexual excitement or indulgence or the use of alcoholic beverages. Were it not for the sexual and alcoholic elements in the production of gleet, the author is satisfied that comparatively few cases of urethritis would last over six or eight weeks.

A lack of rest is another important element favoring chronic urethritis. In every case of virulent inflammation in which the patient is so situated that he is compelled to be on his feet the greater part of the time, to walk about, or indulge in muscular strains, lifting, etc. we may expect a stubborn course of the disease. As a corollary it is to be inferred that patients enjoying facilities for comparative quiet will recover promptly in the majority of instances.

Duration.—The duration of chronic urethritis is very uncertain: it depends mainly upon the curability of the various pathological conditions of the canal upon which the perpetuation of the chronic urethral inflammation depends. In some instances a complete cure is impossible, judging by the frequency with which cases are encountered that have undergone every known method of treatment for a number of years without success.

Some cases of alleged gleet cannot be cured simply because of the pertinacity with which the patient clings to the idea that he is in a serious condition, over-treatment being the most natural result. One meets with numerous cases in which the patient is practically cured, but in which it is impossible to convince him that such is the case. These cases of psychopathic gleet go from surgeon to surgeon, vainly seeking a cure for something which does not exist.

Too prolonged and energetic treatment is often responsible for the perpetuation of chronic urethritis. Many cases are observed in which improvement occurs only upon complete cessation of treatment.

Cases of chronic urethritis are occasionally seen that defy all measures of treatment.

Treatment.—The treatment of chronic urethritis requires more radical measures than are warrantable in the acute stages of the affection, and incidentally a greater variety of remedies, these being necessitated by the varying character of the special causes that tend to the perpetuation of the inflammation.

The first step to be taken is to explore the urethra, and thus determine, if possible, what particular local condition is keeping up the difficulty. For ordinary purposes the bulbous flexible French bougies will be found to be all that is necessary for this purpose, for in the majority of instances a knowledge of the existence of a localized spot of inflammation or stricture is all-sufficient, ocular inspection being of little or no advantage. In the hands of the expert the bulbous bougie readily determines with a great degree of accuracy the condition of the urethra. Otis's acorn-tipped metallic sounds may be used, but the soft instruments are preferable.

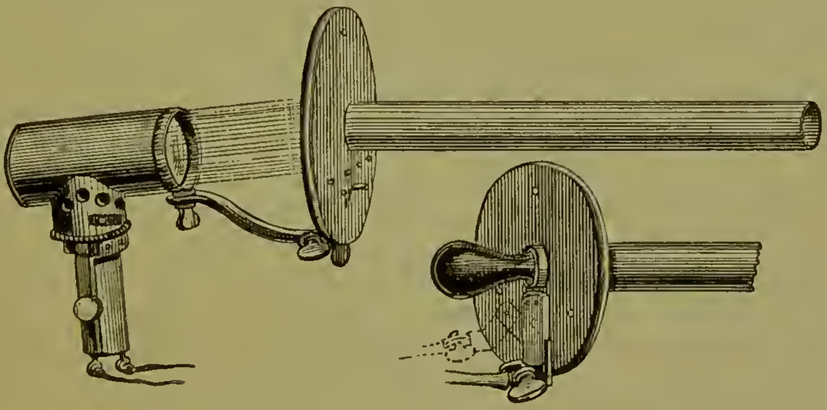

FIG. 45.—W. K. Otis's "perfected" urethroscope.

The endoscope (Fig. 46) bears a somewhat similar relation to urethral exploration that the stethoscope does to the diagnosis of disease of the thoracic viscera. The physician who becomes expert in physical diagnosis finds that the unaided ear is all-sufficient for practical purposes in the exploration of the chest, the stethoscope becoming necessary only in very obscure cases or those in which critical and hair-splitting differentiation of objective signs becomes necessary. There have been numerous elaborate endoscopes devised, but for practical purposes the ordinary straight hard-rubber or silver tube, with the addition of a strong light reflected from a laryngoscopic reflector or from one of the modern small reflecting electric lamps, is sufficient. It is well to have a series of tubes, in order that an instrument may be selected which is as large as the capacity of the urethra will permit.

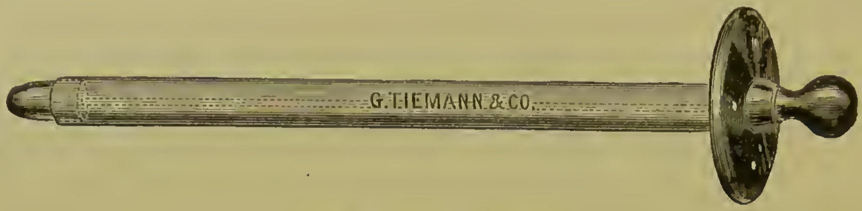

FIG. 46.—Klotz's endoscope.

In case stricture exists, preliminary dilatation may always be practised prior to endoscopy, and it thus becomes possible to use relatively large tubes for exploratory purposes. The mistake is often made of having these tubes made too long; by crowding the penis well down around the tube a short tube can be used much more effectively than larger ones.

We will first consider those cases the chronicity of which depends chiefly upon constitutional conditions or a general predisposition to catarrhal fluxes of various kinds, and in which exploration fails to detect any local condition that will explain the discharge. Cases frequently arise in which all forms of internal and local treatment fail of their object because of inappreciation of the constitutional peculiarities of the patient. Debilitated and strumous subjects and those who are cachectic from any cause whatever require the administration of tonics, such as quinine, iron, cod-liver oil, and various preparations of nux vomica. In cases of this kind the tincture of the chloride of iron or the mineral acids sometimes accomplish wonderful results by improving the general systemic condition, toning up the relaxed and flabby mucous membranes, and inhibiting excessive secretion. It is in these cases, too, that we are apt to have excellent results from the internal administration of vegetable astringents, ergot, etc. Turpentine in moderate doses is occasionally of decided advantage; the tincture of cantharides may also be of service.

Local measures of treatment are often unnecessary. In fact, it will be found that it is in just such patients that the prolonged use of injections and balsamic preparations are inclined to perpetuate gleet. In some instances, however, in conjunction with measures to improve the general health it will be found advantageous to make local applications. One of the best preparations is the pure fluid extract of hamamelis, applied by a cotton-wrapped probe through the endoscope tube. This will never be found to be too strong, and it is a singular circumstance that patients who are unable to bear an ordinary injection in the strength of one part of hamamelis to four of water make no complaint of the application of the pure fluid extract in this manner. It is sometimes necessary to alternate the applications of this astringent with the use of an ointment of nitrate of silver, ten grains to the ounce, in combination with stramonium or belladonna, by means of the cupped sound. Tannin may be used in the same manner. In making any of these applications the patient should first be directed to urinate; a full-sized sound should then be passed to press out the contents of the dilated follicles of the urethra, after which the medicated application is made.

A plan that has proved efficacious in some instances is the prolonged use of hot water in combination with the acetate of lead, the patient being instructed to inject the urethra for fifteen or twenty minutes, night and morning, with water as hot as can be borne. The treatment is to be concluded by syringing the canal with fifteen drops of a saturated solution of the acetate of lead in a teacupful of hot water. This is to be thrown into the canal four or five times in succession. In a few instances of catarrhal gleet the author has succeeded in checking the discharge by the use of a watery solution of ordinary alum, in the strength of a dram to eight ounces night and morning.

It may be considered absurd to advocate a change of climate for patients with this form of chronic urethritis, yet when the general condition seems to demand it this plan may be advised, and will be found to be productive of marked benefit.

The rheumatic, gouty, syphilitic, and tubercular diatheses will be found to be responsible for some cases of chronic urethritis. These conditions require the same remedies as under other circumstances; the combinations of mercury, iodide of potassium, and colchicum are apt to be particularly serviceable in the three former conditions. The various balsamic preparations may be continued during the course of treatment for chronic urethritis, providing the stomach and kidneys are tolerant of these drugs.

Stricture of the urethra is the most frequent cause of chronic urethritis. Its treatment will be considered in a subsequent section.

Congested and granular patches require local applications by means of the endoscopic tube. It should be remembered in this connection that general and powerful applications to the canal are apt to be productive of injury. It is an unfortunate fact that the surgeon seldom localizes his efforts to cure the complaint, but continues the use of caustic and astringent applications and the internal administration of the balsams in a futile effort to relieve something that perhaps a single well-directed application will cure. It is necessary to determine the precise location of the diseased area and to measure accurately its distance from the meatus, with or without ocular inspection of the part. The passage of a steel sound upon alternate days for a few weeks will cure a large proportion of these cases by crushing the minute granulations, emptying pus-distended follicles, producing local absorption of the infiltrated material in the mucous membrane, toning up the latter, and stimulating repair. When this method of treatment has been proven to be ineffectual, strong applications of the nitrate of silver or the sulphate of copper may be made directly to the diseased spot through the endoscope. The pure crayon of sulphate of copper or nitrate of silver is safe if very cautiously used. The silver may be fused upon the end of a blunt probe and touched to the spot very lightly. In lieu of the pure caustic, strong solutions of copper or silver may be used, thirty to sixty grains to the ounce being admissible, but great care is necessary not to leave an excess of the caustic fluid upon the mucous membrane. When the diseased point is within three inches of the meatus the urethral speculum is often serviceable in making applications. The meatoscope may also be useful. It is in cases of chronic urethritis that the methods of treatment by soluble bougies and retro-injection are apt to prove of the greatest service.

Experience has shown that many cases of urethritis are perpetuated by a contracted meatus, behind which urine and inflammatory products accumulate and produce irritation. It is advisable to perform meatotomy as a matter of routine in every case of chronic urethritis in which the meatus will not admit a full-sized sound. The incision should be made with a straight, blunt-pointed bistoury and kept open by the frequent introduction of a short sound or a fossal bougie.

In some cases of gleet dependent upon congested and granular patches of mucous membrane there exists a slight thickening of the underlying mucous membrane, hardly of sufficient importance to be termed a stricture, yet requiring the same treatment, and eventually terminating in a constriction of the lumen of the canal. These patches of tough and resilient infiltration are usually found in the pendulous portion of the urethra, and in such cases the gleet is absolutely resistant to all measures of treatment until a urethrotomy is made and the thin layer of thickened tissue divided. When this process extends entirely around the circumference of the canal it necessarily constitutes a stricture of large caliber, but it is well to remember that the relation of the thickened tissue to gleet is precisely the same in those cases in which, on account of the circumscribed limitation of the process, no pronounced narrowing of the canal is evident, as in those where an acknowledged stricture exists. It is to be remembered, furthermore, that in many cases which are termed "stricture of large caliber" there is really not a strictured condition of the canal, but as the instruments pass over a thickened, granular, and hyperesthetic patch there occurs, just at the location of the lesion, spasm of the accelerator urinæ and compressor urethræ muscles that gives rise to the same objective symptoms as stricture. It is probable that urethrotomy is performed many times for the relief of strictures of large caliber in which true organic stricture does not exist, and there is only the condition of affairs just described to explain the obstruction to the introduction of instruments and the grasping of the bulbous bougie as it is withdrawn from the canal. This fact, however, is no argument against the necessity for urethrotomy.

When the inflammatory process has extended to the deep or prostatic urethra deep injections are absolutely necessary. The instrument of Ultzmann or one of its modifications (Fig. 47) may be used for this purpose. The author has devised a more capacious syringe than that of Ultzmann, which he prefers to any he has seen. Nitrate of silver, sulphate of copper, and sulphate of thallin are the best drugs for use in these cases of deep inflammation. Soluble prostatic bougies and astringent ointments are occasionally of great service in posterior urethritis—*i. e.* follicular prostatitis.

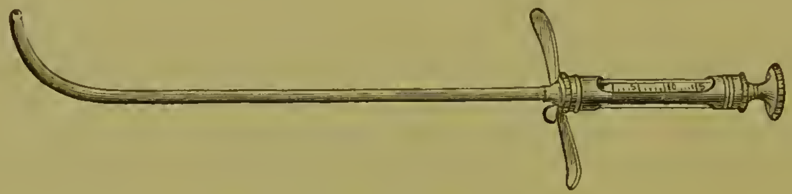

FIG. 47.—Keyes-Ultzmann syringe.

As far as his own experience goes, the author has found the sulphate of thallin in a 15 to 20 per cent. solution the best antiseptic and astringent application for routine use in the posterior urethra. His usual plan is to alternate the thallin with irrigations of nitrate of silver or potassium permanganate in varying strength. In some cases in which there is chronic inflammation of the bulbous urethra we may succeed in exciting healthy action by irrigating the canal with hot iodized water of the strength of one dram to the pint. In quite a number of obstinate cases the author has had excellent results from the use of a mixture of balsam of Peru, compound tincture of benzoin, and iodoform introduced through the endoscopic tube:

℞. Iodoformi,	ʒiv;
Tincturæ benzoini compositæ,	
Balsami peruv.,	*āā.* ℥j.—M.

The following is also useful, applied in the same manner:

℞. Iodinii resub.,	gr. xx;
Eucalyptol.,	gr. ij;
Potassii iodidi,	gr. ij;
Glycerini tannat.,	gr. ss;
Ac. carbol.,	gr. xx;
Boroglyceridi,	q. s. ad ℥ij.—M.

Mild solutions of iodine and glycerin are often of great value in the treatment of chronic urethritis, the urethra being painted, *viâ* the endoscope, with solutions of from three to ten grains to the ounce. Stronger solutions may be used in selected cases, but it is well to be cautious in their application.

All measures of treatment of chronic gleet will fail if the surgeon does not advise his patient against various sexual, dietetic, and other general causes of perpetuation of urethritis, and if the patient does not follow instructions to the very letter. It is an unfortunate fact that the average patient with chronic urethral disease lays the responsibility of his case upon the shoulders of the surgeon, and expects a cure to be accomplished without the slightest co-operation on his own part. The capacity for deceit on the part of the average patient with urethral disease is something astonishing. It is certainly a discouraging thing to have a patient present himself with acute or subacute urethritis a month or six weeks after he has apparently been cured of stricture and gleet, and have him solemnly vow that he has not played the glutton or *roué* during that time. It is possible that a few such patients do not lie to the doctor, but it would be difficult to convince the expert that, in the absence of an exciting cause, a canal which has been thoroughly dilated and the secretion of which has been entirely checked can spontaneously lapse into an acute inflammatory state so long after an apparent cure.

It is possible that patients with sexual difficulties are no more deceitful than those who present themselves for the cure of other affections, but this is not the impression the surgeon is likely to derive by observation of such cases. It might be supposed that the average individual has sufficient respect for his own physical interests to be entirely frank and honest with his physician, and it has been aptly said that "The man who deceives his doctor is a fool." But, as far as his experience goes, the writer is inclined to believe that if this proposition be true, imbecility is largely prevalent in our community. Whether the moral turpitude of the venereal patient is due to a sense of shame, akin to that which impels him to apply the water-closet theory to the origin of his disease when he is well aware of the true origin, or to a desire to lessen his financial responsibility to his surgeon, is a question that it would be difficult to answer. To say the least, it is safe to assume that there is no class of patients so unreliable as those met with in genito-urinary practice.

Treatment of the Complications of Urethritis.—It is necessary to say a few words regarding the special treatment of the complications of urethritis.

Severe Chordee and Urethral Hemorrhage.—This is best controlled by the administration of the anaphrodisiac remedies already recommended and the application of the cold-water coil or a balloon-rubber ice-bag. The danger of hemorrhage is lessened by the proper management of the chordee. When severe bleeding does occur as a consequence of rupture of the corpus spongiosum from forcible straightening of the penis, it may be controlled in most instances by the cold coil. If this is unsuccessful, a gum catheter may be passed into the urethra beyond the point of rupture, and the cold-water coil wrapped tightly around the penis; a firm bandage may be applied without the catheter. The oil of turpentine is often of great service in urethral hemorrhage.

Folliculitis and Peri-urethral Phlegmon.—These conditions are best treated on conservative principles in the majority of cases. As soon as either of these complications manifests itself, injections and all stimulating methods of treatment should be stopped, and, if possible, the patient should be kept perfectly quiet. Hot applications will usually bring about resolution of the swelling after a time. Some cases are very stubborn, but, as a rule, the little tumors characteristic of folliculitis become absorbed; sometimes, however, they remain as small circumscribed indurations and appear to keep up irritation. Under such circumstances they should be excised. Excision is recommended by some authorities as routine practice, under the supposition that the tumors inevitably suppurate, and that there is great danger of rupture into the urethra, followed by extravasation of urine, etc. The author thinks, however, that, as a rule, when the inflammation of the urethra subsides to such an extent that the duct of the follicle becomes patent, the little tumor discharges its contents into the canal, and the wall of the follicle eventually shrinks down to its normal size, this discharge of its contents being usually evidenced by a sudden increase in the urethral discharge. The follicles may refill and again discharge an indefinite number of times, and cause a succession of reinfections of the canal. Should the swelling be marked or painful, or if the fluctuation be evident in peri-urethral phlegmon, an incision must be made at once; this has not been necessary, however, in a number of cases which the author has seen. Conservatism, it is true, may be carried too far, but it is presumed that the intelligent surgeon will know when to cut.

Conservatism is not so applicable in case of peri-urethral phlegmon in the perineal portion of the urethra as in cases involving the pendulous portion of the canal. When the perineum becomes hard and brawny, it is best to make an early incision, the operation being in itself harmless. If in such instances an abscess has formed and opened into the urethra before the patient comes under observation, the case should be carefully watched and free incisions made. If at any time a marked increase in the perineal swelling, chills, hectic, and general constitutional disturbance should occur as evidences of new purulent foci or urinary infiltration, or if the swelling in the perineum is extensive and there is a disposition to pointing of matter at any particular spot, external perineal section is required. In such cases a fistula results that is likely to heal spontaneously, but may require surgical attention later on.

Retention of Urine.—The conditions producing retention are to be considered carefully in dwelling upon its treatment. We must remember that the factors in its production are several—viz. (1) inflammatory swelling of the mucous membrane and consequent diminution of the caliber of the urethral tube; (2) irritation produced by the acid urine; (3) prostatic congestion; (4) muscular spasm. In patients who have suffered from previous attacks there may be stricture to which the foregoing factors are superadded as plus conditions. A prostatic abscess may exist, causing retention by simple pressure.

The indications for treatment are plain—sedatives, derivatives, antispasmodics, alkaline diluents, and rest comprising the main features.

A full dose of morphine hypodermically or per rectum, and a hot sitz-bath to be repeated as occasion demands, are useful. Ice in the rectum sometimes assists in relieving local congestion. Leeches to the perineum and anus are often very effective. Hot demulcent infusions are of service. If prostatic abscess exists, incision is necessary.

An injection of cocainized oil into the urethra may be of service. The dread of painful micturition and the reflex effect of the irritating urine is often an important factor in the production of retention; cocaine may possibly relieve this. The catheter should be used only as a last resort. It is far better, in the author's opinion, to tap above the pubes than to use the catheter, other things being equal. If for any reason it is decided to catheterize, an anesthetic should generally be given; cocaine, however, may be used. The greatest gentleness should be exhibited in the passage of the instrument. Before passing it the urethra should be thoroughly and deeply flushed with a mild, warm antiseptic solution. By these means we may possibly avoid infecting the deep urethra and bladder. In the author's experience instrumental interference has rarely been necessary.

Prostatitis.—The treatment of prostatitis is considered in the section on Diseases of the Prostate.

Cowperitis.—Cowperitis requires rest, the application of leeches, and the prolonged use of hot applications. Should the perineum become tense and brawny, or should there be severe pain and retention of urine, an incision into the swelling must be made without waiting for the formation of pus. If at the end of a week or ten days improvement does not occur, an incision is warrantable in any case. It will be found, however, that in many instances the inflammatory process will resolve without the formation of pus, particularly if the cellular tissue of the perineum is not extensively involved. Cowperitis is not always the result of gonorrhea. The author has seen a typical case of the disease in a tuberculous patient who had no urethral difficulty. Even when allowed to break spontaneously, the pus usually appears externally. It may, however, open into the urethra and result in the formation of fistula or infiltration of urine, abscess, and sloughing.

Acute Cystitis.—The indications for treatment in this complication of urethritis are simple and exceedingly plain. Rest, a milk diet, anodynes per rectum, per os, or hypodermically, hot sitz-baths, hot rectal irrigations, saline laxatives, with or without mercurials, alkaline diluents, plenty of pure water, and demulcent drinks, comprise the principal therapeutic resources in this condition. Hot fomentations, turpentine stupes, or poultices over the hypogastrium are often serviceable in general cystitis.

The list of drugs for internal administration comprises such preparations as pichi, kava-kava, uvi-ursi, cubebs, sandalwood oil, pareira brava, triticum repens, linseed, and slippery elm. Some of these medicaments are available only in the form of infusion, others in that of fluid extracts. Acetate of potassium, benzoate of sodium, liquor potassæ, salol, boracic acid, and salicylate of sodium are all serviceable drugs for their antacid, antiseptic, and soothing effect.

Epididymitis and orchitis will be considered in another section.

Gonorrheal Rheumatism.—The treatment of this complication is not satisfactory, being of a palliative rather than a curative character. The treatment for urethritis should usually be persisted in, for, as a rule, the sooner the local condition improves the sooner the rheumatism will yield. If, however, the discharge has ceased, it is best to let the urethra severely alone. When patients are debilitated, tonics, such as strychnine, quinine, arsenic, iron, and cod-liver oil, are of advantage. The skin and bowels should be kept active and elimination favored by the use of pilocarpine hypodermically. Pain should be relieved by the use of opiates; hot applications and fixation of the inflamed joint are essential for the same purpose. Should the knee be involved, Buck's extension apparatus should be applied. The application of fifteen or twenty leeches to the joint will often prove serviceable. Flannels wrung out of hot water and sprinkled with turpentine are useful. As the inflammation subsides blisters or iodine will be found to promote resolution. Mercury and iodide of potassium internally are of great service in the chronic stage of the disease. The author has had excellent results from intra-articular injections of iodoform emulsion. It is well in all cases to try the effect of the salicylates, inasmuch as the rheumatic or gouty diathesis may exist as a predisposing cause. The more important joints, such as the knee, are best treated by the plaster-of-Paris bandage as soon as the acute inflammation has subsided. Passive movement and perhaps measures to break up the ankylosis are required later. Turkish and electric baths, static electricity, friction, and massage are serviceable adjuvants. Static electricity is particularly beneficial. The author has been much impressed with the value of this remedy in neglected cases of chronic enlargement of the joints. During the acute stage of gonorrheal rheumatism a milk diet is very essential.

The ocular complications of gonorrhea belong to the province of ophthalmology, and their treatment does not concern us here.

Bubo.—The slighter forms are curable by rest and the application of iodine. In the severer forms the patient should take to his bed and apply hot linseed-meal poultices sprinkled with laudanum every two hours. The hot poultice is the best pus-prophylactic at our command. Should resolution not occur promptly, extirpation of the enlarged glands is indicated. If we operate aseptically before peri-adenitis and infection of the surrounding tissues have occurred, healing is generally quite prompt. This may seem radical, but the author has become thoroughly disgusted with the tiresome method of waiting for a bubo to suppurate, and then waiting for weeks or months for it to heal. If prompt healing does not follow a radical operation, the tissues are still in much better shape for subsequent granulation and cicatrization than if a distinct abscess be allowed to form.

Balanitis and Vegetations.—Circumcision will prevent balanitis in cases of redundant and phimosed prepuce. In default of circumcision, absolute cleanliness may prevent balano-posthitis. When this complication comes on the indications are to keep the parts clean and dry. Astringent and antiseptic lotions and absorbent powders are useful. The iodide, sulphate, or acetate of zinc, alum, bichloride of mercury, permanganate of potassium, and many other drugs are serviceable in mild solutions. Finely triturated bismuth, calomel, lycopodium, oxide of zinc, and oleate of zinc are valuable. The last-named drug is perhaps the best of all if a good preparation be used. The stearate of zinc is another elegant preparation. Severe balanitis may require a dorsal incision of the prepuce to expose the parts for inspection and treatment.

Vegetations should be cut away with the scissors and their bases cauterized with fuming nitric acid or the actual cautery. Cleanliness, dryness, and perhaps circumcision, are necessary to avoid their recurrence. The same principles of treatment should govern here as in balanitis.

STRICTURE OF THE MALE URETHRA.

Stricture of the male urethra is by far the most important of all the surgical diseases of the genito-urinary apparatus. It is of importance not only because of its extreme frequency—the special condition that most often gives rise to it affecting sooner or later a large proportion of male humanity—but because of its important relations to secondary pathological conditions of organs more vital than the structure primarily affected.

Stricture of the urethra may be defined as an abnormal diminution of the lumen of the canal at one or more points or throughout its entire course, due to any cause whatsoever, whether temporary or permanent. Thus it may arise from any of the following conditions:

1. Pressure from without, due to—(*a*) neoplastic formations; (*b*) extravasations of blood or urine from injury; (*c*) purulent collections and infiltrations; (*d*) fracture of the pelvic bones.

2. Spasm of the muscles in and about the urethra, due to—(*a*) direct irritation by lesions of the canal; (*b*) direct or reflex irritation from foreign bodies in the canal; (*c*) reflex irritation from more or less remote pathological conditions; (*d*) the introduction of instruments; (*e*) emotional excitement; (*f*) malaria (?); (*g*) highly acid and concentrated urine, and occasionally oxaluria and gravel.

3. Congestive or inflammatory engorgement of the urethra, due to—(*a*) acute urethritis; (*b*) traumatism of the urethra; (*c*) inflammation in and about organic obstructions.

4. Thickening of the urethral walls, due to—(*a*) congestive and granular patches in the mucous membrane—*i. e.* superficial infiltration from chronic inflammation; (*b*) plastic infiltration and formation of connective tissue in the meshes of the corpus spongiosum from severe and long-continued inflammation; (*c*) cicatricial deposit in the corpus spongiosum and urethral walls incidental to traumatism; (*d*) cicatricial deposit incidental to the action of various caustics and powerful irritants; (*e*) cicatricial deposit incidental to ulceration or sloughing from impaction of foreign bodies.

5. Deficient elasticity of the urethral walls and corpus spongiosum—(*a*) from congenital sparsity of elastic and muscular fiber and a preponderance of fibro-connective tissue; (*b*) from inflammation.

6. Congenital narrowing of the urethra or slight atresia from defective fetal development.

7. Polypi of the urethral mucous membrane.

From a clinical standpoint strictures may be divided as regards their origin into—(1) congenital; (2) acquired: (*a*) traumatic; (*b*) chemical; (*c*) acute inflammatory or congestive; (*d*) chronic inflammatory; (*e*) neurotic.

As regards the essential condition producing the obstruction they may be divided into—(1) Spasmodic; (2) congestive or inflammatory (circumscribed or general); (3) organic or fibrous (permanent)—*i. e.* neoplastic.

Those varieties of stricture the nomenclature of which depends upon real or supposed differences in the condition producing the obstruction are not always to be differentiated clinically, because of the fact that the several conditions may coexist and be blended in varying proportions in any given case of the disease. Thus inflammatory or congestive narrowing of the urethra, although sufficient *per se* to produce obstruction in some cases, is nearly always complicated by spasmodic narrowing of the canal. Simple spasmodic stricture is relatively rare, occurring only as a result of reflex irritation of a remote character, mental impressions, or instrumentation where the urethra is very sensitive. On the other hand, spasmodic stricture dependent upon acute or chronic organic changes in the urethral mucous membrane is very frequent. Again, there are few cases of organic stricture that are not complicated at one time or another by inflammation, congestion, or muscular spasm: in fact, all of these elements—which the author styles plus conditions—and particularly spasm, are apt to require attention at various times during the treatment of organic stricture.

SPASMODIC STRICTURE.

Spasmodic stricture—or, as it may justly be called, pseudo-stricture—may be defined as a diminution of the caliber of the urethra due to spasmodic contraction of the muscular fibers in and about the walls of the canal. Its existence was for a long time denied. It would appear that every-day experience should have taught the practical surgeon at a very early period that such a condition as spasmodic urethral stricture was possible. It seems, however, that such was not the case for some time. The varying caliber of the urethra during the progress of a course of treatment for stricture, or during the natural course of that disease unmodified by treatment, is very strikingly suggestive of the element of spasm, for it will often be found that a stricture which will at one sitting admit a sound of fair size will at another time permit the passage of a very small instrument or perhaps none at all. Complete retention may occur at any time as a result of such exciting causes as acid urine, intemperance, sexual indulgence, and so on. To be sure, spasmodic contraction is associated very often with congestion and inflammation, but in most instances spasm is the preponderating condition in the case. Again, an instrument may be obstructed during its passage into the urethra until after gentle pressure is exerted, when it will pass the point of contraction quite readily. The grasping of the instrument by the urethral walls as it is withdrawn proves conclusively the existence of spasmodic contraction.

Notwithstanding the facility of demonstration of spasmodic stricture, the profession did not accept the existence of this condition until Hancock and Kölliker demonstrated the existence of muscular fibers in the urethral walls. The researches of these investigators, although valuable, unfortunately led to the erroneous inference that contraction of these fibers was the most important element of spasmodic stricture. A comparison of the mechanical effects produced by spasmodic stricture with the power of the muscular fibers which were supposed by them to be chiefly concerned in the production of the spasm will readily demonstrate the fallacy of this belief. The planes of muscular tissue are chiefly longitudinal, and so sparse that, no matter how firmly they might contract, they would be incapable of seriously obstructing the passage of instruments or producing retention of urine. We must, therefore, look farther for the seat of spasm in pronounced cases, and seek for structures the function of which is normally to obstruct the canal and prevent the escape of urine. A group of such structures is found in the cut-off muscle of Cruveilhier, and it is at a point in the urethra corresponding to this muscle or group of muscles that the principal spasm occurs. The last few drops of urine and semen are extruded under normal conditions by the accelerator urinæ and compressor urethræ muscles; simultaneously with this expulsion of fluid the cut-off muscle closes the deep urethra and the neck of the bladder. Spasmodic stricture is merely an intensification of this physiological function, in which, from various sources of irritation, the muscle is spasmodically contracted and the volitional power of the patient over the act of urination is for the time being held in abeyance. The accelerator urinæ and compressor urethræ muscles play but a minor part in the production of such spasm, the chief factor being the contraction of the voluntary cut-off muscle: a certain amount of spasm, however, due to contraction of the circular fibers of the urethra, may occur at any portion of the canal, and probably constitutes a certain proportion of the obstruction experienced in the introduction of instruments in cases of stricture of large caliber located in the pendulous urethra. It is this spasm that facilitates the exploration of the urethra by means of bulbous instruments, inasmuch as it is through it that the sensitive urethra resents at certain diseased points the introduction and withdrawal of the bulb, and thus gives evidence of obstruction.

The site of spasmodic stricture varies. There are nearly always two points of spasmodic contraction: (*a*) At the point of irritation; and (*b*) in the musculo-membranous urethra.

1. When a foreign body is introduced into the canal the urethra resents the liberty at any point of irritation, and there occurs simultaneously with the slight contraction at the point irritated a reflex spasm of the cut-off muscle. The same is true in cases of organic stricture in the penile portion of the urethra or at the meatus. The introduction of an instrument produces stretching and irritation of the lesion in the anterior portion of the canal, and excites reflexly spasm of the deep urethra, so that we find, in quite a large proportion of cases of stricture, at least two points of obstruction—one in the diseased portion of the canal against which the instrument impinges, and another when the instrument strikes the deep urethra. The same spasmodic contraction results when the anterior obstruction is a congenital stricture or point of normal contraction. This is an important point, for it has been established that, simultaneously with the removal of the anterior point of obstruction and irritation, the supposed deep organic stricture disappears.

2. The entire canal may be spasmodically contracted and resent the introduction and withdrawal of instruments.

3. The musculo-membranous region may alone be involved. This happens in cases in which an organic lesion exists in the deep urethra and those in which spasm is due to reflex causes.

Causes.—The causes of spasmodic stricture may be classified as—

1. **Predisposing Causes.**—(*a*) General hyperesthesia; (*b*) local hyperesthesia. Both of these conditions are modified by a nervous temperament, debilitated and cachectic states of the system, the rheumatic and gouty diatheses, intemperance, high living, faulty sexual hygiene, etc.; (*c*) acute or chronic disease of the urinary organs. The latter is the most frequent predisposing cause, and it is rarely indeed that a case of spasmodic stricture is met with in which a more or less damaged state of the canal does not exist. So uniformly is it present that it is always to be suspected until organic disease has been excluded by exploration. Congested and granular patches, erosions of the mucous membrane, acute and chronic urethritis, and stricture of whatever degree constantly predispose to spasmodic contraction, both at the point

of irritation and at the cut-off muscle; such predisposing causes are almost always effective in its production during the passage of an instrument. A congenital narrowing of the meatus or other parts of the canal may give rise to reflex spasm of the deep urethral muscles in any case in which an instrument is passed of sufficient size to produce stretching of the sensitive tissues at the point of contraction. As already noted, when instruments are introduced under the pathological conditions alluded to there is a spasm at the site of the lesion and another deep down in the canal.

2. **Exciting Causes.**—1. Passage of instruments; 2. sexual excitement or excess; 3. injury to the canal, chemical or traumatic; 4. a debauch; 5. cold-taking; 6. foreign bodies; 7. drugs, such as cantharides and turpentine; 8. reflex irritation; 9. malaria (?); 10. mental emotions.

A survey of the various exciting causes of spasmodic stricture is sufficient to indicate the fact that in nearly all instances the element of spasm is associated with congestion and inflammation—conditions that such special causes are most apt to excite. Spasm due to drugs is usually associated with considerable inflammation and attended by frequent and painful micturition, perhaps associated with urethral hemorrhage. The most frequent exciting causes are intemperance, exposure to cold and wet, and sexual excess. Highly acid urine in gouty patients is said to act as an exciting cause *per se* in some cases, but it is in the highest degree doubtful if such a condition of the urine can bring about obstructive spasm in a perfectly healthy canal. It is, however, an important element in spasm produced by excesses of various kinds and cold-taking. Instrumentation of a sensitive canal, especially if organic disease exists, may develop spasmodic stricture lasting for some days or weeks.

Cases of intermittent spasm due to malaria and curable by quinine are recorded, but it is questionable whether malaria alone can act directly as an exciting cause; that it may predispose to spasm is admitted.

In passing instruments into the virgin urethra in delicate and nervous patients—whether organic disease exists or not—the instrument is apt to meet with obstruction in the deep urethra. This will generally pass off under gentle and continuous pressure with the beak of the instrument. As the instrument is withdrawn a sense of biting or grasping upon it is experienced by the hand of the operator, and the patient may himself feel a sensation of traction in the urethra.

It is a matter of common observation that some individuals are unable to urinate in the presence of others. This has been in all probability due not to spasm *per se,* but to inhibition of volitional power over the cut-off muscle and normal involuntary contraction of the detrusor urinæ muscle.

Reflex spasm of the cut-off muscle is most apt to arise from irritation of structures bearing a more or less direct relation to the genito-urinary tract through community of nervous supply; thus diseases of the bladder, kidneys, rectum, and anus are very apt to produce it. Retention is by no means uncommon after forcible stretching of the sphincter ani in operations for hemorrhoids, fistula in ano, and rectal stricture. Inflammation in and about the perineum may produce urinary obstruction through the medium of spasm, independently of pressure.

The practitioner should consider the possible occurrence of deep spasmodic stricture in every vesico-urethral disease, acute or chronic. The point from which irritation is reflected may be above or below the site of the spasmodic contraction—*i. e.* the perineo-urethral muscles.

During a gonorrhea the urinary flow may be greatly lessened, yet sufficient for all practical physiological needs, when suddenly retention occurs, and this without the slightest involvement of the deep urethra or bladder. Ordinarily retention means a deep extension of inflammation, but retention from this cause is not so sudden, and is preceded by symptoms of prostatic or vesical irritation. In chronic prostatic irritation and in chronic cystitis with or without calculus acute retention may occur. In such cases congestion constitutes the primal condition of obstruction; but it is the reaction of the muscular structures to irritation that brings about the sudden and final occlusion of the urinary way, with resulting complete retention. Spasm plays the principal rôle and congestion the preparatory.

In hypertrophy of the prostate the least disturbance of the usual regimen or the slightest venereal or dietetic excess or exposure causes congestion of the deeper parts of the urethra. This may excite reflex contraction of the surrounding muscles, with consequent retention.

Some interesting examples have been cited where irritation of neighboring parts has produced spasmodic retention. Thus, Le Dentu cites a case of testicular neuralgia the exacerbations of which were accompanied by spasmodic retention. The same author calls attention to the providential spasmodic retention that often prevents urinary extravasation in wounds of the urethra and perineum.

Uterine affections in women have been known to give rise to spasmodic retention, and it is probable that post-partum retention often has a strong spasmodic element.

It has been held that injuries of parts very remote from the urinary apparatus may produce spasmodic retention; thus, a fall upon the knees, fractures of the ribs, surgical operations (such as laparotomy), and many other accidents of a traumatic character are sometimes associated with retention. That this retention is due to spasm the author does not believe. Inhibition of the detrusor urinæ or of volitional power over the cut-off muscle, due to shock, commotio cerebri, or commotio spinalis, seems a much more logical explanation. There may, indeed, be an apparent retention due to reflex inhibition of renal secretion, especially after abdominal operations. In some cases obtunding of the sensory supply of the bladder from shock or concussion may have much to do with the temporary retention. In some of the slighter cases exaltation of emotional sensibility may be a causal factor. A patient who has been operated upon or seriously injured is compelled to use a duck or bed-pan, often with an attendant close at hand; the result is a temporary inhibition of the power to relax the cut-off muscle.

There is a condition that Dr. Fessenden Otis has termed urethrismus, or chronic spasmodic stricture, which is by no means infrequently seen, and may result from various sources of irritation more or less remote. This condition may be due to chronic abscesses in and about the genito-urinary organs. Dr. Otis has reported a very interesting case of this kind due to fistula and chronic abscess of the scrotum and testicles of long standing.

Dr. Otis's remarks upon the subject of urethrismus are well worth repetition: "The term spasmodic stricture has usually been applied to all temporary contractions of the urethra which interfere in any degree with either the passage of instruments into the bladder or the voluntary discharge of urine from it. As thus understood, it has been described as varying in degree from the slight localized muscular spasm, which but momentarily arrests the progress of an ingoing instrument, to the firm, close contraction which more or less persistently resists its introduction in skilled hands, or from that which occasionally diminishes the strength of the outgoing stream of urine in micturition to that producing complete and enforced retention of urine.

"In whatever degree present in any case, it is claimed by all authorities to be characterized by its transient duration and its readily yielding to remedial measures. In accordance with this teaching, all permanent or habitual interference with urination or the passage of instruments (except in some rare instances complicated by vesical paralysis) must have an organic cause, and depend either upon the presence of an intravesical growth, an enlarged prostate, or close organic stricture. It is also within the experience of many surgeons to see supposed subjects of close organic stricture placed upon the operating table for the performance of external perineal urethrotomy, which, when fully anesthetized, astonish the operator by permitting the full-sized exploratory staff to slip easily into the bladder. In other cases the entire absence of that peculiar resistance to the knife which the experienced surgeon recognizes when dividing cicatricial tissue, and the failure to locate with exactness the contracted point, will suggest to the memory of some that occasional patients, similarly affected, have not escaped so easily.

"Not infrequently, persistent difficulty in urination, and perhaps retention of urine requiring the habitual use of the catheter, has been observed by surgeons where no proofs of intravesical growths were present and the easy passage of an ordinary catheter precluded the idea of enlargement of the prostate or of close organic stricture.

"If it can be proven that purely spasmodic urethral contraction may, and not infrequently does, present all of the important diagnostic features of the true close organic stricture, and, further, if it can be shown that polypoid and prostatic obstruction is often simulated by chronic spasm of the accelerator urinæ muscles, producing obstruction and persistent closure of the membranous urethra, then it will be conceded that failure to appreciate so important a complication will conduce to grave errors in diagnosis, terminating possibly in an operation for conditions which exist only in the mind of the surgeon."

It must at once be apparent to every experienced and practical surgeon that Dr. Otis has given us in the foregoing remarks a most valuable and practically reliable principle in genito-urinary surgery. So evident, too, is the point involved that one is inclined to wonder that it remained for Dr. Otis to discover. It is found, for example, that in quite a large proportion of cases of penile stricture a sound which is large enough to put the contraction on the stretch either will not enter the bladder or does so only with great difficulty. A bulbous, flexible bougie of any size will not enter at all, and even if a small one does succeed in passing the deep urethra, it is firmly grasped on withdrawal, the sensation imparted to the hand being not always deceptive to the expert, but to the surgeon of little or moderate experience constituting irrefutable evidence of deep organic stricture.

The association of spasmodic contraction of the deep urethral muscles with disease of the kidneys has not attracted special attention. It is an element, however, of the painful and frequent micturition incidental to nephritic stone and pyelitis. The author has a case now under observation in which there was marked urinary obstruction coincidental with an acute exacerbation of pyelitis, although the urethra had previously been entirely free from obstruction. In such cases there may be associated with the reflex spasm more or less neuralgic pain of a reflex character in the back, groins, hypogastrium, and thighs. The author recognizes the fact that in these cases there exists the special irritating factor of a morbid condition of the urine.

Diagnosis.—The diagnosis of spasmodic stricture is usually comparatively simple, particularly in those cases in which retention comes on suddenly. It is obvious that the sudden occurrence of retention in a case of organic stricture or other obstructive lesion of the genito-urinary tract, in which the stream of urine has been previously only moderately lessened in size, must depend upon some complicating condition—either inflammation and congestion at the site of the organic lesion, spasmodic contraction of the cut-off muscle, or both conditions in combination. A certain degree of inflammation or congestion is to be inferred in every case of spasmodic retention of urine, and requires due consideration; the predominating element of spasm is, however, the principal feature. As a rule, in cases of sudden retention of this kind there is a history of some one or more of the exciting causes that have been enumerated.

In determining the dependence of retention of urine upon spasm it is necessary to remember that in by far the majority of cases there is some organic foundation for the condition. When in the course of treatment for organic stricture of small caliber retention suddenly occurs, the predominating condition is usually congestion or inflammation. The occurrence of acute urethritis during the course of severe organic stricture is apt to superinduce sudden retention. The condition in these cases, although a spasmodic element exists, is mainly congestion and inflammation at the site of the stricture, which produces sufficient swelling completely to close it for the time being. Urethritis produced by the introduction of instruments brings about retention in the same way. Cases of stricture of large caliber in which there is little or no obstruction to the passage of urine may suddenly develop retention from spasm. It is doubtful whether congestion or inflammation even produces closure of the canal in such cases.

It is sometimes difficult to determine during instrumentation how much of the obstruction to the passage of instruments is due to organic contraction and how much to spasm. For example, after an instrument has passed a stricture of large caliber in the penile portion of the urethra or an inflamed and irritable meatus it will be found to be obstructed in many cases as it enters the membranous region. A steel instrument is less likely to be obstructed than a soft bulbous one, and the spasm is more likely to yield to steady and gentle pressure against it with the point of the sound than to a soft bulb. If there be organic contraction in slight degree at the bulbo-membranous junction, a steel instrument small enough to pass the stricture in the anterior portion of the canal will, in all probability, slip by and fail to detect it. A large bulbous instrument will usually fail to pass altogether, but if a small bulbous bougie (Fig. 48) be introduced, it will be found that the spasm of the surrounding muscles, although insufficient to obstruct the passage of the instrument into the bladder, will at the same time pucker the stricture together, so to speak, so that the shoulder of the instrument impinges upon it as it is withdrawn. The peculiar feel imparted to the bougie and the sudden snap produced by the passage of its shoulder through the organic contraction will determine the exact nature of the case.

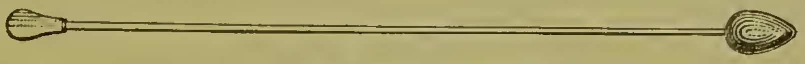

Fig. 49.—Bulbous bougie.

It will thus be seen that a comparatively small bulb may detect an organic contraction with predominating spasm in the deep urethra where a very large steel sound fails to do so. The peculiar sensation of elasticity imparted to the instrument as it impinges against the portion of the urethra that is spasmodically contracted will usually give an expert a tolerably accurate idea of the real condition of affairs. On account of the spasm that is usually encountered there are very few individuals indeed in whom a stricture in the deep urethra cannot be demonstrated by the bulbous bougie. If, however, a small instrument be passed and carefully and slowly withdrawn, organic contraction may usually be excluded. The ordinary sound cannot be relied upon for a diagnosis.

There are some exceptional cases of chronic spasmodic stricture in which the real condition can only be demonstrated by the subtraction of all sources of irritation, direct or reflex, after which the supposed organic stricture disappears.

Treatment.—Obviously, the first indication in the treatment of spasmodic stricture is to remove all predisposing causes as far as possible. Such conditions as the gouty and rheumatic diatheses require correction. General nervous irritability and hyperesthesia may require nervine tonics or sedatives and antispasmodics, or both, according to the special indications present. The principles of genito-urinary and sexual hygiene should be thoroughly impressed upon the mind of the patient. Once succeed in disabusing his mind of the fallacious notion that his penis and testes constitute the axis around which his earthly existence revolves, and the surgery of the case is much simplified. Every possible source of local and reflex irritation must be removed. This necessarily involves, in the majority of cases, the cure of organic lesions of the urethra. The urine should be kept bland and non-irritating by dietetic measures and the administration of alkaline remedies. Careful study should be given in each case to the degree of tolerance of the urethra for instrumental manipulations. The amount of irritability of the urethra and the degree of spasm excited by the passage of instruments is a fair criterion of the frequency with which they should be introduced in the systematic treatment of organic stricture.

When retention comes on as a consequence of spasmodic stricture, an attempt should be made to relieve the condition by derivation—with the view of removing possible congestion—and antispasmodics. The passage of instruments should be avoided, if possible, as tending to increase irritation and spasm. The full hot bath and morphia by the mouth or hypodermically should be depended upon as far as practicable. Very often the patient will succeed in passing urine while in the hot bath. When it is found that these simpler measures fail to relieve, a small soft catheter should be carefully introduced—while the patient is in the bath, if possible. If necessary, chloroform or ether may be given to the extent of full anesthesia for the purpose of relaxing the spasm and facilitating the passage of instruments. Whenever retention comes on in the course of organic stricture, it must be remembered that the accident is not due to the organic contraction *per se*, but to certain plus conditions—*i. e.* spasm, congestion, and edema of tissue in varying proportions. The relief of the retention depends upon the subtraction of these plus conditions from the primary predisposing factor of organic contraction. The treatment of urethrismus is chiefly operative. After all sources of reflex irritation have been removed the urethrismus disappears.

CONGESTIVE OR INFLAMMATORY STRICTURE.

This is usually a complicating condition rather than a pathological entity, being much less frequently met with as a prime factor in the case than spasm.

Even the rare existence of congestive and inflammatory stricture as an essential condition is denied by many surgeons, but it would at least appear to be the main feature of a minor proportion of cases of urinary obstruction with or without retention. This congestive or inflammatory obstruction may occur —(1) as the result of occlusion of the urethra by extensive infiltration of the mucous membrane, periurethral connective tissue, and corpus spongiosum in severe or virulent urethritis; (2) at the site of an injury to the mucous membrane produced by instrumental or accidental trauma from within or without the canal; (3) as a consequence of acute urethritis affecting strictures of large caliber or congested and granular patches of the mucous membrane.

Necessarily, the most frequent variety of congestive or inflammatory stricture occurs in connection with organic stricture. It is often a difficult matter to determine in exactly what relative proportion the elements of spasm and congestion exist.

Some cases of congestive stricture exhibit a marked hemorrhagic tendency, either as a consequence of instrumental interference, sexual indulgence, or in rare instances without apparent cause. The author has noticed this symptom with especial frequency in syphilitics and patients with a tendency to varices.

Treatment.—The indications for treatment of congestive or inflammatory stricture are the same as in spasmodic stricture, which is usually a complicating factor, with the exception that in cases in which it is believed to be a prominent element or the predominating condition the application of leeches in the course of the urethra, particularly in the perineal region, is advisable.

ORGANIC STRICTURE.

Organic, permanent, or fibrous stricture is that form in which the narrowing of the urethral caliber is due to an aggregation of connective-tissue elements, either congenital or acquired. It is most often acquired and most frequently met with between the ages of twenty-four and forty-five.

Very rarely does a stricture give trouble for the first time after the age of forty. It may occur at any time after the period of puberty. The frequency of stricture between the ages mentioned is easily explained by the fact that it is at this period of life that the individual is most subject to urethritis—the most frequent cause of stricture.

Traumatic Stricture.—Traumatic organic stricture may occur at any age. The youngest case that has come under the author's observation was a boy of thirteen, who was operated upon several years ago by external perineal section. In this case the stricture recontracted, probably from neglect on the part of the patient, and is now with difficulty kept open. Another operation will eventually be required. Erichsen records a case of traumatic origin in a boy eleven years of age.

Traumatic stricture is usually located at the triangular ligament. It is at this point that the urethra is most likely to be injured by blows or falls. A fall astride a hard object or a kick in the perineum is the usual cause. The bulbo-membranous urethra is caught between the impinging body and the sharp knife-like lower border of the subpubic ligament, and a very slight degree of force may therefore produce permanent injury. It does not require a very great degree of violence to sever the urethra completely in this situation. The pendulous urethra, on the other hand, is rarely involved in traumatic stricture on account of the difficulty with which it can be caught between two impinging bodies.

No matter what the location of traumatic stricture may be, it is composed of cicatricial tissue, the extent of which depends upon the degree of destruction of the urethral walls that has given rise to the stricture. Obviously, such a stricture is the worst with which we have to deal. It is rarely amenable to dilatation and usually requires a perineal section.

Urethral Stricture in the Female.—It is obvious that the female sex enjoys relatively great immunity from stricture of the urethra. This is explicable by the shortness and simple structure of the canal and the extreme rarity of urethritis in the female. The author has never seen but one case of the kind, and that occurred in a masturbator, probably as a consequence of laceration by the introduction of foreign bodies. Erichsen records a case occurring in a woman, but does not state the probable cause. Van de Warker, however, has shown that stricture in the female is more frequent than is generally supposed, and has reported a number of interesting cases.

Otis has also asserted that stricture of the urethra is more often seen in women than is generally believed. Symptoms which in men would be at once attributed to a stricture of the urethra are in women attributed off-hand to an irritable bladder. It has been asserted that stricture may occur in lithemic female patients independently of any infectious or inflammatory process, and require the same treatment as in men.

Congenital Stricture.—The congenital form of stricture is rare, if we exclude narrowing of the meatus. The existence of congenital stricture below a point one-fourth of an inch from the meatus is denied by the majority of surgical authorities. If, however, we take into consideration the occasional occurrence of congenital atresia of a part or the whole of the urethra, the possible occurrence of localized congenital narrowing of the canal seems logical. The author has seen a number of cases of linear stricture of the pendulous portion of the canal that he believes to have been of congenital origin. It may be asserted that such cases are traumatic and due to masturbation. This is admitted to be possible. In speaking of cases of congenital stricture points of slight relative contraction that may be demonstrated in nearly all subjects are not included.

Congenital stricture of the meatus is a relative affair, inasmuch as it is not, *per se*, productive of discomfort in by far the majority of cases. An individual with a meatus narrower than the average is not likely to be annoyed thereby, providing he never contracts gonorrhea.

As has already been said in the section on anatomy, there is a wide variation in the size of the meatus in different individuals, and there is very frequently not only a narrow meatus, but a distinct linear contraction of the canal about one-fourth of an inch within it. When a urethra with such an external orifice becomes affected by inflammation, or when it is found necessary from any cause whatever to explore the urethra or bladder, the meatus at once assumes a position of pathological importance, inasmuch as it is impossible to explore satisfactorily—and more difficult, if possible, thoroughly to treat—a urethra of moderately large caliber if the meatus is narrow, even by the use of the urethrometer.

In order to determine the condition of the urethra or to treat organic disease of the mucous membrane the meatus must admit instruments of a size corresponding to the largest mean diameter of the canal. Obviously, when the normal caliber of the urethra is 38 French, it is impossible satisfactorily to explore or treat it when the size of the meatus is only 30 French. Otis's urethrometer in the hands of the expert has obviated the difficulty of exploration in such cases, but it is by no means as satisfactory or as safe an instrument for routine exploration as the bulbous bougie. Whenever, therefore, there exists a suspicion of urethral, prostatic, or bladder disease and the meatus is contracted, it should be enlarged by incision to a sufficient size to admit an instrument that will thoroughly distend the canal.

In by no means exceptional instances a contracted meatus of congenital origin has been known to induce reflex neurotic disturbances in very much the same manner as does a phimosed prepuce. Irritability of the bladder with frequent micturition, and perhaps other symptoms more suspicious of stone, have been known to arise from this cause. The author has met with a number of cases of this character, and one more interesting still in which atony of the bladder resulted. The connection between the vesical atony and the contraction of the meatus was demonstrated by the success that followed meatotomy.

A congenital narrowing of the meatus may be due, as already mentioned in connection with the anatomy of the urethra, to partial occlusion by a thin membranous septum at its inferior commissure, the fossa navicularis terminating in a pouch behind it. In others, however, the narrowing is due to exceptional thickness of the tissues of the glans below the meatus. In the first of these conditions the meatus may stretch easily when instruments are passed. In the latter, however, the introduction of an instrument of sufficient size to distend the meatus produces spasm—in some cases of the entire canal and in any event of the cut-off muscle. It will be seen, therefore, that it is not alone the size of the meatus that is important, but its dilatability and degree of tolerance of instrumentation. Whenever, during the passage of an instrument, the meatus is drawn tightly about it in a thin white line, it is safe to conclude that that particular instrument cannot be introduced into the deep urethra without the exhibition of unwarrantable force.

Varieties of Organic Stricture.—According to conformation, organic acquired stricture occurs in four principal varieties—viz. (1) The first and simplest form is known as the linear stricture, the obstruction corresponding to that which would be produced by tying a narrow cord about the canal. (2) The second variety is wider, and is known as the annular form, the condition being mechanically similar to that which would result from tying a flat band or piece of tape about the canal. (3) The third form—which is divided by some authorities into several peculiar sub-varieties—involves a considerable extent of the urethra in an irregular contraction, and is known as tortuous stricture. For practical purposes these three varieties are sufficiently distinctive.

As regards their clinical features, strictures may be described as—(*a*) simple and readily dilatable; (*b*) irritable, involving local hyperesthesia and hyperemia; (*c*) resilient or elastic; (*d*) recurrent. This classification necessarily depends largely upon the behavior of the stricture under treatment.

Linear strictures present themselves in several different forms. In some cases there exists one or more membranous septa occluding the canal to a greater or less extent. These are sometimes known as bridle or pack-thread strictures. There may be a number of these bridles, the orifices of which may or may not correspond. In some cases the bands are transverse, and in others oblique in direction. Their orifices may correspond to the center of the canal or may be located at one side. Occasionally the septum or band has a crescentic form and involves only a portion of the canal. The precise method of formation of these bridles and bands is open to question. It is not generally supposed that it is possible for inflammatory lymph to become exuded upon the surface of the mucous membrane. This question would be difficult to settle, however, in the absence of abundant post-mortem evidence. It may be accepted as a possibility in cases in which the mucous membrane has been injured by instruments or by chemical irritation. The theory has been advanced that in some cases the bridles are due to the fusing together of the natural rugæ of the flaccid canal. In some instances the condition results from a tearing up of the valvular flaps of the mucous membrane by the careless introduction of instruments. In others it is possible that a certain amount of atrophy of the submucous connective tissue and mucous follicles occurs, giving rise to a loose flap of mucous membrane. That the natural folds of the mucous membrane may fuse together, so to speak, and form part of a stricture mass, the author firmly believes from conditions found in some cases of perineal section.

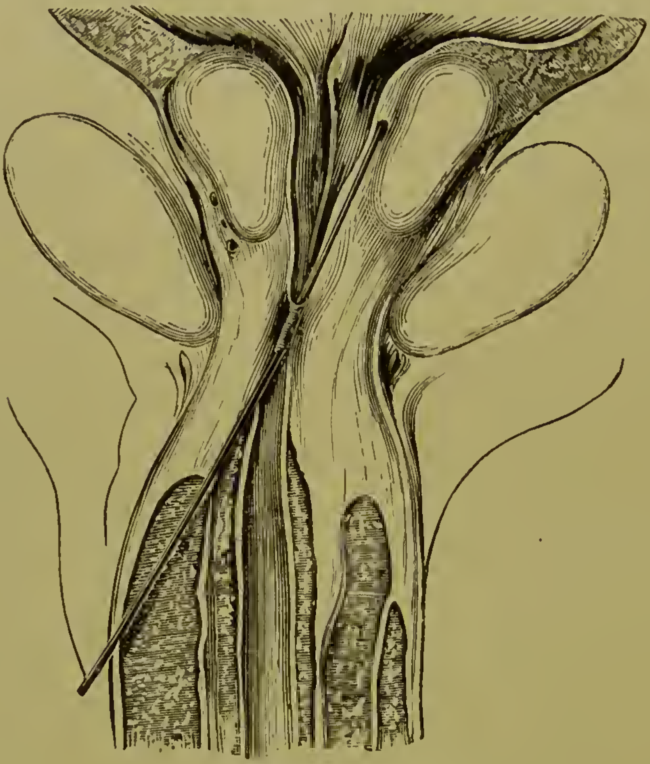

FIG. 50.—Annular stricture (Dittel).

Annular stricture (Fig. 49) may be due to thickening of, and interstitial deposit in, the mucous membrane or to submucous inflammatory infiltration. Probably in some few instances of apparent annular stricture of large caliber, observed clinically, superficial thickening of the mucous membrane exists in the form of congested and granular plaques at a point of normal relative inelasticity of the urethra. This lesion need not necessarily involve the entire circumference of the canal, although it apparently does so on account of the coincident spasm, for as soon as the bulbous bougie impinges upon such a sensitive spot the urethra contracts down in front of the shoulder of the instrument, giving the same sensation as it is withdrawn as would be imparted by a decided narrowing of the canal. Obviously, it would be impossible to determine whether such a lesion involves the entire circumference of the canal or only a circumscribed patch except by endoscopic examination.

Tortuous strictures are made to include all strictures above one-fourth to one-half inch in width. They are irregularly contracted—*i. e.* narrower at some points than at others, as a rule. The whole pendulous urethra may be involved, but always in a varying degree. The fact that an extensive tortuous stricture is narrower at certain points than at others is explicable upon the same ground as the localization of congested and granular patches and stricture of large caliber in the pendulous urethra—viz. the existence of normal points of relative inelasticity at which the inflammatory process is necessarily more aggravated than in other portions of the canal. As already remarked, the formation of some tortuous strictures may perhaps be explained by the fusing together of the natural folds of the canal. If we admit the spiral or rifled form of the urethra in the flaccid condition of the penis, it is conceivable that pronounced infiltration of the corpus spongiosum may permanently fix it in its tortuous conformation.

The number of strictures is variable. It has most generally been accepted that stricture is usually single, but it will be found that in by far the majority of the cases—if the urethra be carefully explored—more than one stricture exists. The surgeon who believes that a urethra which will admit a good-sized sound is necessarily free from stricture is apt to recognize only the more marked cases occurring in the bulbo-membranous region, whereas if familiar with the occurrence of strictures of large caliber he might discover by careful exploration in a given case several strictures in the penile portion of the canal. Dr. Otis's investigations, while perhaps tending to exaggerate the frequency and multiplicity of strictures, have certainly shown not only that a stricture of large caliber may exist in cases in which the urethra will admit of a sound of good size, but that strictures of the pendulous urethra are much more frequently seen than has commonly been supposed. Some of these so-called multiple strictures consist of irregular contractions of a long, tortuous stricture.

The amount of contraction in cases of stricture varies greatly between those of large caliber, in which there is but superficial thickening with loss of elasticity of the mucous membrane, and those severe forms of long-standing stricture in which the lumen of the urethra is so contracted as to resist the introduction of a fine bristle, even when the stricture is exposed post-mortem. The contraction is seldom sufficient completely to prevent the passage of urine. It has been claimed by excellent authorities that in this sense impermeable stricture does not exist. This statement, however, is probably incorrect, for it is conceivable that the urethra might be so completely destroyed from traumatism that the resultant stricture would close completely. The same is true of any organic stricture in case fistulæ form behind it and divert the urine from its normal channel.

The explanation of the rarity of strictures impermeable to urine is a very simple one. Every intelligent practitioner knows how difficult it is to heal a fistula in the tissues that communicates with the secreting structures or a cavity containing materials that escape and enter the lesion. Urinary fistula, fistula in ano, and salivary fistula are familiar illustrations. The patency of urethral stricture is not only facilitated by the passage of the urine, but also by the fact that the mucous membrane is usually intact, or at least in part. The inflammatory deposit, as a rule to which there are few exceptions, occurs in and beneath the mucous membrane, and produces obstruction by pressure upon it, instead of by fusing the opposing surfaces of the urethral walls together. Just so long as an intact strip of mucous membrane, however narrow, exists in the track of even the most tortuous stricture, just so long is it permeable, strictly speaking.

Strictures impermeable even to instruments are also very rare, particularly in the practice of surgeons who exhibit sufficient patience, gentleness, and skill in instrumentation. A stricture should not be pronounced impermeable because at one or perhaps a dozen attempts it is found impossible to pass an instrument, for sooner or later, particularly if appropriate general measures of treatment be instituted, an instrument will usually be found to pass; and, no matter how small it may be, the successful passage of a bougie at once gives the surgeon almost complete control of the case. The most competent andrologist may fail to pass a stricture, but it must be remembered that impermeability of a stricture at one end of the bougie may mean a lack of tact or patience at the other.

Location of Stricture.—The location of stricture has been the subject of much controversy. Dr. Otis's investigations in particular have modified in certain quarters the existing ideas of the relative frequency of stricture at different points in the urethra. That the views of Otis have not been allowed to pass unquestioned goes without saying.

Until recently the dicta of Sir Henry Thompson and others of his school upon the location of stricture have been universally accepted. Thompson found in 320 cases of stricture, examined clinically, 212 that were located at the bulbo-membranous junction, 51 in the spongy portion of the canal, at variable points between 1 inch anterior to the opening of the triangular ligament and 2½ inches posterior to the meatus, and 54 at the meatus or within 2½ inches posterior to it. In 270 cases examined post-mortem he claimed a decided preponderance of stricture in the bulbo-membranous region, which he describes as the space included between a point 1 inch anterior to the triangular ligament and another ¾ of an inch posterior to it. H. Smith examined 98 preparations of stricture in the London museums, and found only 21 in the membranous urethra, the other 77 being anterior to it. The majority of the latter were situated in the bulbous urethra or just in front of it. Otis claims—and the author thinks correctly—that stricture is most frequently found in the penile portion of the canal. It is obviously impossible for the Thompson and Otis schools to arrive at harmonious conclusions as long as their standards of stricture and methods of exploration remain so widely different. Post-mortem evidence is only relatively valuable. The surgeon who reasons from clinical experience and skilfully uses the urethrometer and bulbs can never agree with Thompson, and must acknowledge the accuracy of Otis's methods, even though he may consider his conclusions somewhat overdrawn.

It has been the author's experience that the most frequent site of stricture appears clinically to be at the meatus or just within it, most of these cases, however, being congenital. The next most frequent point is the junction of the bulb and fossa navicularis, or just posterior to it—*i. e.* 2½ to 3 inches from the meatus. The next most frequent location is the bulbo-membranous junction, and the next about 1 inch anterior to it. It seems to occur with varying frequency in the intermediary portions of the canal.

As Otis remarks, it will be found that strictures occur, as might naturally be expected, with greatest frequency where the inflammation begins the earliest and rages the hottest, the frequency gradually diminishing in the deeper portions of the canal.

From a clinical standpoint the author has come to regard stricture as any condition of the urethra that is capable of producing friction by obstructing the flow of urine to however slight an extent, providing said obstruction and friction are productive of pathological disturbances, or, if the latter have already begun, tend to perpetuate them. A point of normal contraction or relative inelasticity becomes a stricture only when the urethra assumes a pathological state; the previously normal lack of distensibility is then of great pathological and surgical importance, and its removal may be imperatively necessary.

Believing, as the author does, that any point of contraction or inelasticity in the urethra in the presence of a pathological condition of the mucous membrane constitutes a stricture, he can unhesitatingly reiterate his firm conviction that stricture of the urethra is most frequent in the pendulous portion of the canal. If care be taken to exclude the element of deep urethrismus—which exclusion is not as easy as some authors would have us believe—the proportion is, he thinks, at least ten to one. That great variance of opinion exists upon this point is well known, and Bumstead and Taylor long ago called attention to the fact that there could be no harmony of results between those who studied the subject upon the living and those whose estimates were formed entirely upon observations of the cadaver. Folet (in 1857) called attention to the frequency of fibrous stricture in the pendulous urethra, and its comparative rarity in the bulbo-membranous region. This author claimed that deep obstruction existed in all cases of stricture of the spongy portion, but that the deep stricture was nearly always spasmodic and secondary to the trouble in the anterior portion of the canal. In 1866, Verneuil coolly appropriated Folet's thunder, and expressed essentially the same views and in very nearly the same language. Otis, writing at a later period, while not so radical as his French predecessors, has promulgated similar views, but in a much more comprehensive and thorough manner. The relation of urethrismus to reflex irritation, more or less remote, as shown by Otis, is one of our most important contributions to the literature of genito-urinary pathology, and is decidedly complimentary to the genius of American surgery.

In estimating the frequency with which deep spasmodic stricture complicates obstruction in the pendulous urethra attention is called to a frequent source of error in diagnosis, although at the risk of repetition of some points previously outlined. While a deep stricture may be demonstrated in nearly if not quite all cases, it does not necessarily follow that such deep strictures exist at other times. The tender urethra resents a foreign body quite as vigorously as does the eye, and as soon as the sound touches a tender spot or sensitive stricture, even of large caliber, in the pendulous urethra, a pronounced reflex contraction is observable throughout the entire canal. This is, of course, most pronounced in the deep portion. A spasm of the pendulous portion is not usually regarded as of importance; indeed, some surgeons discredit it altogether. It will be found, however, that the spongy portion often contracts so closely about the sound that it is felt to be firmly grasped during withdrawal all along the canal. This "clonus" in the pendulous urethra is of great assistance in diagnosis, as it serves to force diseased portions of the canal down in front of the shoulder of bulbous instruments of a caliber much smaller than the stricture will readily admit. Thus it often happens that a good-sized sound will pass by obstructions upon which quite small bulbs will catch.

In some cases, as already stated in the discussion of spasmodic stricture, deep spasm exists more or less constantly; but in many of these cases there is an actual organic change at the site of the spasmodic stricture; this may be true organic deposit, an erosion, or a congested and granular patch. Under such circumstances it is often very difficult to determine, even approximately, the proportionate relation of spasm to organic lesion. Oftentimes the true condition of affairs can only be determined by subtracting the sources of reflex spasm in the anterior urethra by urethrotomy.

The prostatic portion of the urethra is never involved in true stricture, so far as known. Thompson says on this point: "I may confidently assert that there is not a single case of stricture of the prostatic portion of the urethra to be found in any of the public museums of London, Edinburgh, or Paris."

The dicta of authorities on this questions are correct only as regards acquired stricture. The author has dissected several specimens in which congenital narrowing and distortion of the distal portion of the prostatic urethra existed. In one case a distinct musculo-membranous bridle extended across the prostatic urethra.

Pathological Localization of Stricture.—The predilection of stricture for different portions of the canal has not, apparently, been satisfactorily, or at least clearly, explained. The explanation usually given for the relatively greater frequency of occurrence of stricture in various portions of the canal, more particularly in the bulbo-membranous region, is that there is in these situations a greater amount of erectile tissue and a more marked tendency to localization of inflammatory processes than in other portions of the canal.

There are several points to be considered in the explanation of the occurrence of stricture in any particular location, and in some instances there are certain special elements in its production that are worthy of attention.

Acquired strictures at or just within the meatus are favored by the existence of congenital narrowing at this point. There is a constant obstruction to the passage of urine, and the friction thereby induced inevitably enhances inflammation. There is, moreover, a tendency to pocketing of secretions behind it, and these secretions—primarily acrid in the case of virulent products of inflammation—are likely to decompose very speedily and aggravate the existing inflammation. The introduction of the nozzle of the ordinary syringe in injecting the urethra necessarily produces considerable irritation when the meatus is very narrow. These considerations explain the frequency with which acquired stricture is found just within the meatus. Long-nozzled syringes often produce stricture at a little distance within the meatus by the frequent impact of the point of the instrument against the inflamed mucous membrane. At such a spot of irritation the inflammation will necessarily become localized and chronic.

The relative dilatation of the bulbous portion of the spongy urethra and of the fossa navicularis undoubtedly favors the retention of a small quantity of urine and of pathological discharges at these points, but this element in the causation of stricture is not very important until actual obstruction by inflammatory thickening of the mucous membrane occurs just in front of the dilated area. Under ordinary circumstances these expanded portions of the urethra are thoroughly flushed out from time to time by the urine. When, however, stricture begins to form there will inevitably be a small quantity of decomposable fluid left in the canal in these situations. The author thinks, however, that this condition is of little importance until the stricture becomes very thick, as the residual urine is not allowed to remain undisturbed for any great length of time. The urethra is relatively somewhat expanded just behind the juncture of the fossa navicularis with the spongy urethra, and at this point also similar conditions prevail.

Strictures produced by injury to the canal during the passage of instruments necessarily occur at the site of the lesion thereby produced. Inasmuch as the principal obstruction to the careless passage of instruments, even in the normal urethra, is found at the opening in the triangular ligament—*i. e.* the bulbo-membranous junction—it is at this point that such strictures are most apt to be found.

Traumatic strictures produced by falls and blows upon the urethra correspond to the site of the injury. It is very difficult, however, to catch the pendulous urethra between two impinging bodies unless it is done with deliberate intent to produce injury. In the case of the deep or fixed urethra, however, injury is very readily produced by falls and blows upon the perineum. Strictures produced in this way occur most frequently at the bulbo-membranous junction, for, as already stated, this point corresponds with the opening in that tense fibrous septum, the triangular ligament, and with the sharp lower border of the subpubic ligament; this latter structure is of a semi-cartilaginous consistency, and its edge is almost as firm and resisting as a narrow border of bone. It is between this hard tissue and the impinging body that the urethra is usually caught in injuries of the perineum, and it takes but slight force to produce sufficient injury to the canal to result in traumatic stricture. Comparatively slight force may sever the urethra completely. Injuries unnoticed in early life may produce organic stricture later on. Traumatic strictures are, on the average, the worst variety with which we have to deal.

The location of stricture due to the introduction of strong chemical or caustic substances into the urethra may be determined by the same normal anatomical conditions as in the case of ordinary virulent urethritis. They may, on the other hand, occur at the point chiefly affected by the caustic or chemical substance.

Foreign bodies in the urethra may produce localized inflammation, and perhaps ulceration, which determines the site of a subsequent stricture. Most often a foreign body lodges in one of the dilated portions of the canal. Under such circumstances the foreign material produces the most pressure and irritation at that point in the mucous membrane at which its outward passage with the flow of urine is obstructed.

Injury incidental to chordee is often responsible for the localization of stricture. This condition interferes with the normal distensibility and elasticity of the urethra, and during erection produces a strain upon the tissues of the corpus spongiosum and urethra at some particular point or points. The point of greatest convexity of the curve produced by the chordee is, as a rule, the point at which the greatest strain is experienced. The irritation produced by this straining of the tissues is apt to induce the localization of stricture at this point. In some instances the corpus spongiosum or mucous membrane of the urethra yields to the tension and is lacerated to a greater or less extent. This may be produced by the patient forcibly bending the penis with the fatuous idea that rupture of the chordee will cure his gonorrhea. The author believes, however, that in marked cases it may result from frequent and vigorous erections, the occurrence of laceration being unrecognized, save perhaps in some cases in which the patient calls the attention of the surgeon to the fact that there has been more or less hemorrhage during the night. This, in his opinion, is a frequent cause of stricture. Under the circumstances mentioned the subsequent stricture occurs at the site of the injury. Whenever any appreciable quantity of blood appears in a gonorrheal discharge such minute traumatisms may be inferred. These slight injuries often form the groundwork for future stricture-building.

By far the most important element in the determination of stricture at special points in the urethra is the existence of certain normal anatomical peculiarities of the structure of the canal. These are the chief bone of contention among the warring factions whose *casus belli* is the question, To cut or not to cut? It has been shown by Weir, Sands, and others that there are certain points of narrowing in the spongy portion of the canal that have been termed by them normal contractions, these being distinct from the normal points of contraction usually recognized—namely, the meatus, the bulbo-membranous junction, and the point of union of the spongy urethra with the fossa navicularis. This description appears to the author to be somewhat misleading. The urethra is an elastic tube susceptible of considerable dilatation. Its elasticity, however, is not uniform throughout, but as a consequence of sparsity of elastic tissue, with a preponderance of connective and fibrous tissue in the erectile structure of the corpus spongiosum and a deficiency of areolar tissue beneath the mucous membrane, there exists at various points relative inelasticity and limited dilatability of the urethra. It is well known that in certain portions of the canal relative inelasticity and limited dilatability are due to certain anatomical peculiarities of the surrounding structures. For example, at the opening in the triangular ligament the urethra is not only narrow, but is surrounded by dense and unyielding tissues. The meatus is comparatively inelastic in most individuals, even when it cannot be said to be congenitally contracted. The corpus spongiosum is a little thicker at the junction of the fossa naviculāris with the spongy urethra and at the junction of the latter with the bulb. At these various points, moreover, the areolar tissue beneath the mucous membrane is disproportionately scanty, and the latter is more closely applied to the tissues upon which it rests. It would seem also that, as there is normally more strain at these points of narrowing than at any other portion of the canal, the urethra is here reinforced by an increased density of fibro-connective tissue.

In explaining the localization of stricture we will take as our point of departure the fact that the urethra is a dilatable tube, the elasticity of which varies at different points in the canal. Through this tube water at a certain pressure and in a certain volume is forced at more or less frequent intervals. Obviously, the greatest friction is produced at the various points of normal contraction and relative inelasticity. Against the strain and friction produced at these points nature has provided a certain amount of reinforcement of tissue, and under normal circumstances, with a healthy mucous membrane, the pressure and friction do not produce injury. When, however, the canal is inflamed, as in acute urethritis, its lumen and elasticity are decreased. Urine is nevertheless pumped through the tube in as great a volume and with as great frequency as under normal circumstances, producing by its mechanical pressure, friction and chemical effects considerable irritation, as evidenced by the subsequent pain and smarting. Obviously, the greatest amount of irritation from friction, chemical action, and pressure occurs at the points of relative inelasticity of the canal, and as a consequence it is here that inflammation tends to localize itself, and persists, perhaps long after the remainder of the mucous membrane has returned to a condition to a greater or less degree approximating the normal. This continual friction and irritation is interpreted by the controlling centers and nervous supply of the part as a demand for reparative material, and as a consequence there must inevitably be more or less plastic deposit at these points. This plastic deposit is a conservative effort on the part of nature to prevent injury by the increased strain and irritation and secure physiological rest. Unfortunately, however, this conservative process is in this instance misapplied, for if complete absorption does not occur, the exuded inflammatory material remains, organizes, contracts, and constitutes a stricture.

The existence of the points of relative inelasticity referred to also explains abraded, congested, and granular patches of the mucous membrane in all instances in which they are not due to the frequent contact of instruments. The relatively greater amount of friction at such points tends to produce abrasion of the mucous membrane and removal of its epithelium more frequently than at any other points of the urethra. Rapid removal and re-formation of cells results in impaired vitality and a vicious habit of cell-formation. This is one of the most important factors in chronic urethritis.

To sum up: The process of formation of stricture may be illustrated by a rubber tube of delicate structure and small caliber through which water is pumped in a certain volume at more or less frequent intervals and at a certain degree of hydrostatic pressure. If this tube be compressed at certain points, or if it be tied in such a manner that, although not compressed, it is prevented from distending perfectly under the strain of the water, it is easy to see that it is at the point of obstruction that the tube is most apt to give way, or, after a time, to wear out. If the lumen of the tube be diminished, the volume of water that is poured through it remaining the same, the strain upon its texture at these points will be greatly increased, and it will give way much sooner. When, as a consequence of localization of inflammation upon the surface of, and infiltration of the areolar tissue beneath, the mucous membrane it becomes less elastic, as is the case when congested and granular patches occur from any cause whatever, there exists the same relative inelasticity and obstruction, and as a consequence a deposition of young connective tissue, with resulting formation of stricture, is apt to occur sooner or later. The friction produced by the urine is the principal explanation for the steady increase in thickness and contraction of organic strictures. The extent of stricture-deposit depends on the degree of strain and friction present.

The physiological and biological elements in the localization of stricture must not be forgotten: the vicious habit of cell-formation already alluded to is of great importance. In the course of acute urethritis there is a tendency to rapid formation of epithelium of a low grade. This is a reparative, a conservative, process, but, unfortunately, a certain biological law comes into play here—viz. in inverse proportion to the degree of differentiation of cells is their rapidity of proliferation and their tendency to degeneration. The consequence of this law is an erosion at the point of friction, and, secondarily, a plastic deposit to resist strain. The subsequent metamorphosis into fibro-connective tissue of this deposit is well understood. In the pendulous urethra especially—and probably also in the fixed portion—the plastic deposit may absorb, but the friction remains and a gleet is often kept up. The points of normal contraction and relative inelasticity have now become of pathological importance.

Now, the author wishes to ask, at this juncture, what difference it makes whether these points were primarily present in the canal as normal conditions or not, as regards their surgical relations from the standpoint of treatment. The question is not, whether they are adventitious, as claimed by Otis, or normal, as claimed by Weir and Sands, but what are their relations to the abnormal state of the canal? The difference between the two conditions is one of degree and not of kind, and there would seem, therefore, to be no logic in the dispute on either side.

From what has been said, the author believes, contrary to the usual opinion, that the direct relation of stricture to the severity of the primary urethritis may be clearly seen.

It is a self-evident proposition that if what has been said regarding the relation of stricture to friction be true, the same holds good with relation to granular, congested, and eroded patches in the canal. Within certain limits the indications for treatment may be the same. In addition to the element of friction in producing stricture and other lesions of the urethra, a varying degree of importance of retained secretions and inflammatory products at points of narrowing is acknowledged.

Regarding the importance of the element of friction, Otis says: "It is only necessary to establish the fact that the normal resiliency of the urethra is diminished at a given point to prove that during micturition a perturbation of the stream must occur at such point, even if it is not sufficient to attract attention in any way. Hence the slightest contractions assume an importance which could not be inferred from the apparent freedom from trouble in passing the urine. They establish a localized point of friction, and of necessity an increased excitement in the vessels of the part, possibly only enough to disturb the complete elaboration of epithelial material and to cause a shreddy deposit to take the place of the clear normal secretion; and this may occur with very slight or without the least abnormal sensation being present. The presence of the mucoid shreds in the urine may be the only evidence of commencing trouble. But a permanent point of friction once established, greater than the natural conservative power of the surrounding parts is able to counterbalance, the obstruction is inevitably increased by the aggregation of plastic material at the point of irritation. In this way the tendency to recovery is combated and an area of chronic inflammatory action is established.

"Thus the difficulty, that commenced simply as an obstruction to the resiliency of the urethral walls, progresses certainly and naturally, to the point of narrowing, to a greater or less degree, the caliber of the urethral canal."

When the views of Dr. Otis first appeared they gave rise to much opposition. Among those who most vigorously combated the teachings of Otis was the author's lamented friend, the late Henry B. Sands. Among other arguments, Dr. Sands presented some very carefully prepared casts of inferentially normal urethræ that showed great variation of caliber. What struck the author as most peculiar was the controversy on the question of the normal or abnormal character of many of the penile strictures diagnosed by Otis. Taking into consideration the purely mechanical effects of stricture of the urethra, it is difficult to understand how quibbling was possible. What difference in the results and in the line of treatment could be maintained between a gleet perpetuated by the normal points of friction in the urethra and a gleet perpetuated by acquired stricture? Sooner or later, true adventitious deposit occurs and the point of normal relative indistensibility merges into an acquired neoplastic contraction. Points of relative inelasticity or contraction and points of acquired contraction may be precisely the same from a clinical standpoint in the presence of a pathological condition of the mucous membrane. The cure of the case demands their removal independently of their origin.

Morbid Anatomy of Stricture.—When inflammation becomes localized at any point in the urethra there results an extension of the process to the submucous tissue, or there is an increase in a pre-existing periurethral thickening. This is due to a submucous infiltration of embryonal cells, that soon forms a zone of periurethral sclerosis more or less dense. This may or may not, at the beginning, comprise a distinct thickening of the corpus spongiosum. This process constitutes the *début* of stricture, and is the condition most frequently detected by the bulbs or urethrometer in chronic urethritis. Obviously, it is upon the loss of elasticity at the affected point that the detection of the lesion depends. The same loss of elasticity explains the symptoms and tendency to increasing growth of stricture.

In some instances there will be found a slight thickening of the mucous membrane, with little or no submucous proliferation of connective tissue, the epithelium being more or less denuded and covered with muco-purulent secretion. The follicles of the urethra at this point are dilated, thickened, and disposed to hypersecretion. When the process is a little farther advanced the mucous membrane is thickened, congested, and perhaps covered with fungous granulations, with more or less infiltration and thickening of the submucous connective tissue and the structure of the corpus spongiosum (see Plate 2, Fig. 2). In older and more pronounced cases the corpus spongiosum is extensively infiltrated and of a semi-cartilaginous consistency, often so dense that perfect erection is impossible. This condition is really chronic interstitial inflammation of the corpus spongiosum, which acts precisely like a localized acute inflammation of the same tissue in that it gives rise to chordee. Bridles, bands, or flaps of thickened mucous membrane may be found in different cases.

The degree of occlusion of the lumen of the canal is variable. In some strictures of large caliber superficial infiltration and thickening of the mucous membrane are localized to a very small spot in the urethra—perhaps not involving the entire circumference of the canal—and its lumen is contracted little if any. In the severer forms occlusion may be almost complete.

The secondary results of stricture are chiefly incidental to the urinary obstruction it produces, and vary greatly in degree. In extreme instances all the conditions incidental to urinary obstruction and chronic inflammation of the urinary way have been found post-mortem.

The urethra anterior to organic stricture may be somewhat contracted as a consequence of chronic inflammation of the mucous membrane associated with comparative disuse. The stream of urine that passes through the stricture not being of sufficient size to dilate perfectly the anterior portion of the canal, contraction should naturally be expected. It has been said that the urethra anterior to a stricture is in rare cases dilated. It is difficult to understand, however, how this could occur, unless possibly as a result of extensive atrophy of the submucous follicles and connective tissue.

The obstruction to the flow of urine necessarily first affects the urethra posterior to the stricture. At this point the canal becomes more or less dilated and in extreme cases thinned. As a consequence of interference with the wave of contraction of the accelerator urinæ and compressor urethræ muscles produced by the plastic deposit constituting the stricture, in combination with the dilatation behind it, this part of the canal is never free from urine, a drop or so invariably remaining after the act of micturition; this residual urine finally decomposes and enhances the chronic inflammation. The inflammation is also aggravated by the friction of the urine, and in extreme cases by the straining efforts incidental to its expulsion. As a consequence of the inflammation there will be found at this point a muco-purulent secretion of pasty consistency. This secretion constitutes the discharge in most cases of gleet incidental to stricture. As the urine flows over the diseased part the secretion, in combination with more or less desquamated epithelium, is rolled up in little thready filaments (*tripper fäden*) that may be seen floating about in the urine. There may be considerable congestion of the mucous membrane, so that the secretion is sometimes mingled with more or less blood. This, in the author's experience, is especially apt to be the case in syphilitics.

As a result of urinary decomposition there is likely to be found behind a tight stricture of long standing a deposit of more or less earthy material, perhaps in the form of a calculus. A small calculus of renal or vesical origin may become lodged at this point. In a recent perineal section the author found a calculus of some size behind a tortuous stricture.

As the case advances the mucous membrane behind the obstruction becomes very thin and fragile, and perhaps ulcerated; sometimes, as a consequence of a straining effort during micturition, it gives way, and a drop or two of germ-laden urine escape into the peri-urethral cellular tissue. Abscess with inevitable fistula—or perhaps, as a consequence of burrowing, a number of fistulæ—and infiltration of urine with resultant sloughing and death are possible results. Wherever such fluid as is extruded under these circumstances comes in contact with cellular tissue it inevitably destroys its vitality, with the results just mentioned. It resembles in its destructive effects upon cellular tissue the germ of erysipelas; it produces, in short, a septic cellulitis.

The various glandular structures that open into the urethra posterior to organic stricture are invariably affected to a greater or less extent in marked cases by the urinary obstruction and mucous inflammation. The urethral follicles, prostatic glands, and Cowper's ducts become dilated, thickened, and inflamed as a consequence of infection combined with frequent and straining efforts at micturition. Even anterior to the stricture the sinuses and follicles will be found to be dilated—often sufficiently so to obstruct the passage of fine instruments. This dilatation is due to successive distention with, and evacuation of, inflammatory products. The prostate becomes more or less congested from the frequent bruising incidental to spasmodic and difficult urination. It is possible that this condition is one of the causes of enlarged prostate in advanced life.

The bladder is always more or less involved even in strictures of moderate degree. As a result of the continual obstruction to expulsion of urine the detrusor urinæ muscle becomes hypertrophied. As the obstruction increases the viscus may rarely become dilated, and portions of its walls, where the bundles of muscular fibers are deficient in quantity, become dilated and thinned, as a consequence of which condition sacculi are produced. In these sacculi urine collects and decomposes, and as a result calculi may form. In some rare instances the bladder, instead of being dilated, is enormously thickened from interstitial cystitis, and so contracted that it will hold but a very small quantity of urine.

The mucous membrane becomes the seat of chronic inflammation and assumes a characteristic dusky or slaty hue. It is covered by muco-purulent secretion, perhaps mingled with sabulous material, and is usually greatly thickened and perhaps rugose. Calculi may form in the bottom of the bladder in the same manner as under other circumstances involving urinary obstruction.

Inflammation and dilatation of the ureters and pelves of the kidneys occur sooner or later in extreme cases. Pyelitis, with or without the formation of renal calculi, will be found to exist under such circumstances. Nephritic or perinephritic abscesses may occur. The secreting structure of the kidneys undergoes those changes which are described under the omnibus term surgical kidney.

One of the characteristic conditions observed in surgical kidney is an interstitial proliferation of connective tissue and a deficiency of the elements of the normal stroma. Nature is very prodigal in her supply of reparative material to relieve strain, prevent irritation, or repair breaches of tissue. Obstruction to the urinary outflow results in the accumulation of a physiological army of proliferating cells sent to the renal tissue or developed *in loco* for the purpose of resisting strain, and this strain is interpreted by the trophic centers as a threatened breach of tissue. Unfortunately, this tissue-reinforcement develops no qualities of elasticity as it organizes, but as the strain goes on yields before the pressure and enhances the passive dilatation. Moreover, it not only absorbs almost as rapidly as it is formed, after a certain point has been reached, but it displaces, strangulates, and produces absorption of the normal secreting elements of the renal structure.

In some of the more marked forms of surgical kidney associated with pyelitis, pyelo-nephritis, or pyo-nephrosis we find disseminated suppurative foci in the secretory structure—*i. e.* the cortex of the kidney. These foci may form in two ways: by direct infection—*i. e.* by contiguity of tissue—or indirect infection by pyemic infarcts. Whether this is due to toxins or to germs is not pertinent at this point.

In fatal cases of uremia following operations for stricture the secreting structure is usually found to be intensely congested and swollen from reflex hyperemia, produced by the shock of the operation or the anesthetic.

It is to be remembered that these various consequences of stricture are not due to any specific quality of the lesion, but are the typical results of extreme and prolonged obstructive disease of the genito-urinary tract. As far as stricture is concerned, we have possible pathological results sufficiently numerous and severe to convince the most skeptical that through the medium of stricture gonorrhea is indeed a serious disease. The results of stricture and the operations necessary for its cure are often directly fatal to life. It is this fact that makes gonorrhea a much more dangerous disease than syphilis.

The density of stricture necessarily varies considerably according to the duration of the case, its origin, the habits of the patient, and the amount of irritation present. In old and pronounced cases it may be almost cartilaginous in consistency. Strictures of traumatic and chemical origin are very hard, because a greater or less amount of the normal tissue has been completely destroyed and replaced by true cicatricial tissue.

Causes of Stricture.—The most frequent cause of stricture is urethritis, and it has been said that it is the duration rather than the severity of the inflammation which determines its occurrence; in other words, that a long-continued inflammation of a low grade is the most usual cause. This, however, is open to question, for, while stricture results many times from chronic urethritis, it must be acknowledged that in the majority of cases the symptoms of chronic inflammation are dependent upon the stricture, and the stricture itself upon antecedent virulent inflammation; in brief, it is the stricture that perpetuates the inflammation, and not the reverse.

The author believes it may be safely assumed that the danger of subsequent stricture and of chronicity of urethritis is directly proportionate to the severity of the acute inflammatory process. Repeated attacks of inflammation almost inevitably lead sooner or later to organic stricture. It is probably exceptional that the urethra assumes its normal condition throughout its entire extent for a long time after a virulent urethritis, as there exist in most instances one or more damaged spots in the mucous membrane which in many cases will sooner or later form a foundation for stricture. They will inevitably do so if the patient has a succession of gonorrheas.

Stricture may result from traumatism produced by instruments within the canal or by injury from without. Severe injuries to the perineum usually involve the urethra, and are inevitably followed, as already indicated, by the worst form of organic stricture. When the urethra is entirely cut across or severely bruised the loss of tissue is replaced, as in other situations, by cicatricial deposit. It is disproportionately dense, on account of the lack of rest incidental to urination and sexual excitement. This tissue contracts and constitutes a stricture. Injuries which were apparently trivial at the time, and have perhaps been long forgotten, are not infrequently the source of stricture. It takes but little force to injure the deep urethra, and an accident that has apparently produced little or no injury is liable to produce stricture later on.

Injury to the perineal urethra may result from kicks, blows, and falls astride such objects as a wall or a fence. The author has met with a case occurring in an athlete as a consequence of falling astride a horizontal bar. Fracture of the pelvic bones, gunshot and stab wounds have been known to produce traumatic stricture.

Rupture of chordee often superadds traumatism to the usual inflammatory causes of stricture. Careless instrumentation is sometimes responsible for stricture. It is very easy to force a catheter or sound through the urethral walls, or to produce sufficient injury by bruising and laceration to result in cicatricial deposit and stricture. Cicatrices from chancre and chancroid, occurring at the meatus or within the urethra, inevitably produce stricture.

Urethral injections are popularly supposed to be responsible for a large proportion of cases of stricture, and this belief, it must be confessed, has some foundation in fact; for some surgeons, in their enthusiasm and desire for a speedy cure of their cases, are apt to forget that the urethra is lined by a very delicate mucous membrane, which is normally extremely sensitive to irritants, and is certainly more sensitive than ever when inflamed. Injections of a mild character, given in a proper manner and at the proper period, will not produce stricture, but, on the contrary, tend to prevent it by their beneficial effect upon the inflamed membrane. The prejudice that exists in the minds of the laity regarding the use of injections is to be deplored, as the method is often a very useful one. Although the surgeon may sometimes be responsible for the occurrence of stricture, it is safe to say that in the majority of instances the disease is due to aggravation of the inflammation by a lack of rest, sexual indulgence or excitement, intemperance, and self-treatment. The counter-prescribing in vogue among a certain class of druggists is often responsible for stricture. This is a matter which physicians would do well to take under advisement. There is no disease with which the counter-prescriber takes so many liberties as with gonorrhea. The results are oftentimes very disastrous.

Independently of the strength of injections, it is to be remembered that the blandest of fluids may, when a urethritis is very acute, produce irritation by their mechanical action alone.

It is probable that individual peculiarities are sometimes predisposing causes of stricture. Thompson believes that heredity is a factor in its formation in some instances.

The theory that members of certain families present a marked tendency to connective-tissue and fibrous thickenings in various situations as a result of chronic inflammation is a plausible one, yet it would be difficult to trace the relation of heredity to stricture.

Cachexiæ of various kinds certainly act as predisposing causes of stricture, in so far as they tend to perpetuate and enhance the severity of inflammation in any situation. It has occurred to the author that persons with syphilis are more likely to develop stricture than other individuals. This is probably because a localized proliferation of syphilized cells is apt to occur at any point of local irritation which develops during the active course of syphilis. This is a practical point, as it is obvious that specific internal medication may sometimes be a very useful adjunct to strictly surgical measures. The same considerations apply to the gouty and rheumatic diatheses. Any condition that favors hyperacidity of the urine predisposes to stricture. Patients who are habitual drinkers are more liable to develop stricture than total abstainers. The constant ingestion of alcohol makes the tissues in general irritable and prone to inflammation.

Symptoms of Stricture.—One of the earliest symptoms of stricture of the urethra is disturbance of urination. The decomposition of the small quantity of urine that collects behind the obstruction after the process has become moderately advanced gives rise to organic compounds that are very irritating to the mucous membrane, as evidenced by the chronic inflammation found at this point. This condition causes reflex or direct irritation of the neck of the bladder, with a resulting frequent desire to urinate. Some patients first consult the surgeon regarding an increased frequency of micturition, sometimes occurring only at night. Under normal circumstances the bladder will tolerate its contents during the hours of sleep, but in the presence of irritating affections of the genito-urinary tract it becomes intolerant of the urine and must be frequently evacuated. It is not unusual to meet with strictured patients who have been annoyed by several calls to urinate during the night for a number of years, but have never been troubled in any other way. Oftentimes such patients have a stricture at the meatus only. A stricture at the meatus may give rise to frequent urination by producing reflex irritation of the neck of the bladder, the rest of the urethra being free from disease.

A very frequent early symptom of stricture consists in dribbling of urine after micturition. This is due to interference with the contraction of the accelerator urinæ and compressor urethræ muscles, the function of which is to expel the final drops of urine or semen from the canal. As soon as the penis is allowed to hang downward the residual urine escapes. It is not unusual, even in stricture of large caliber, for imperfect ejaculation of semen to occur, with dribbling after the penis becomes flaccid.

The stream of urine may be forked or twisted, corkscrew-fashion, according to the form of the stricture. In some instances a straight stream will be projected from the meatus, while a second stream falls perpendicularly downward. The size and form of the meatus modifies the form of the stream. In stricture of large caliber a narrow meatus may counteract the effect of the obstruction and maintain the natural form of the stream. When the meatus is large and its lips turgid the stream may present a fan shape, or there may be several streams running in different directions. This occurs in some persons who are free from stricture.

A little later on more or less straining effort is required during the act of micturition, the abdominal muscles being unconsciously brought into play to supplement the action of the detrusor urinæ. As this goes on, more or less atony of the detrusor occurs, and a still greater effort is required to empty the bladder. So severe does the strain become in pronounced cases that hemorrhoids, prolapse of the rectum, and swelling of the prostate may occur.

After a time the stream of urine becomes extremely small, perhaps escaping a few drops at a time, and necessitating the expenditure of considerable time in the act of urination. Ejaculation of semen may now be so interfered with that the fluid, instead of escaping into the vagina as under ordinary circumstances, is forced backward, overcoming the resistance of the veru montanum and passing into the bladder. If this condition of affairs lasts for a long time, the function of the veru montanum may be inhibited completely and permanently, so that the individual ever after ejaculates the greater portion of the seminal discharge into his own bladder. Very often little or no semen will be discharged during the orgasm, for the reason that the increased turgescence of the corpus spongiosum, in conjunction with obstruction produced by the stricture, is sufficient completely to occlude the urethra during erection. The semen under such circumstances may remain in the urethra to dribble away as soon as the organ becomes flaccid. Under such circumstances sterility is an inevitable consequence. Partial or complete impotency may result from stricture as a consequence of the local and reflex enervating influence of the disease. In many instances the irritation of the stricture produces obstinate priapism and excessive desire.

Neuroses from Stricture.—While the majority of cases of stricture are unattended by pain, there are in quite a proportion of instances both direct and reflex symptoms of a painful character. Neuralgic pains in the groins or shooting up and down the spermatic cord, the front of the thighs, and in the lumbar region are not unusual. Neuralgic pains in remote situations are occasionally experienced. The author has met with numerous cases of this kind. One case in particular was very interesting in that an obstinately recurring angina pectoris was apparently cured by a urethrotomy.

The remote or direct nervous disturbances incidental to stricture of the urethra are too often lost sight of in the strictly mechanical aspect of the condition. The decidedly complex relations of the genito-urinary apparatus to the sympathetic nervous system should receive more attention than is usually accorded them. The observations of the reflex neuroses from genital irritation in children are a key to the solution of many problems in the urethral pathology of the adult.

There is a general impression that a stricture is of little importance unless it produces distinct symptoms of urinary obstruction. When, however, one meets with cases of vesical atony, incontinence of urine, impotency, neuralgia of the cord and testes, lumbo-hypogastric and lumbo-sacral neuralgia, profound mental depression and other neuroses, entirely relieved by urethrotomy of strictures of large caliber, the importance of this question is brought before one in a forcible manner. The relation of such conditions to congenital or acquired stricture at or near the meatus is especially marked.

General malnutrition, hypochondria, and malaise are often noted in stricture. Nervous irritability is often a prominent feature. Local pain, referred to the neck of the bladder, rectum, perineum, and hypogastrium, is sometimes experienced.

As the stricture increases in density and narrowness it becomes more irritable, and attacks of complete retention of urine are apt to occur as a consequence of spasm of the urethral and cut-off muscles, with or without congestion or inflammation at the site of the stricture. Acute cystitis may arise as a complication. The plus conditions that cause retention of urine are usually superinduced by sexual excesses, intemperance, or exposure to wet and cold, often in combination with dietetic excesses.

Gouty and rheumatic patients are especially liable to retention. As a consequence of retention rupture of the urethra behind the stricture, or even rupture of the bladder, may occur, the urethra being most likely to give way.

Following retention acute cystitis may develop. The danger of this complication, however, depends to a great extent upon the degree of care exercised by the surgeon in relieving the distended bladder. Infection and traumatism are very easily produced.

Toxemia from Stricture.—The relations of stricture to uremia, so called, is not a new theme. Something will be said later on regarding the relation of the shock from surgical operations upon the urethra to toxemia and consequent urethral fever; the subject is too important for discussion at this point.

The relation of absorption of toxins from the site of the lesion in stricture, or from behind it, to the general results of stricture is unquestionably of great importance. The rapidity with which many constitutional symptoms disappear after cure of deep strictures is thus easily explained. Urethral chill following instrumentation is also explicable in the same way in some cases.

The possibility of mixed infection must be taken into consideration. The cases of cystitis, epididymitis, periurethral phlegmon, pyelo-nephritis, and other special phenomena secondary to stricture are not all dependent upon direct extension of inflammation, but are probably due in many cases to secondary infection. A recent case of the author's is strongly suggestive in this relation. A patient under treatment by dilatation for several irritable strictures of comparatively large caliber developed multiple nephritic and perinephritic abscesses. An interesting point was the fact that the formation of the abscesses was heralded by great increase of irritability and spasm in the deep urethra.

The all-important point is the apparent fact that all patients with serious strictures—particularly of the deep urethra—suffer from a greater or less degree of toxæmia, and that many cases develop secondary single or multiple infections of one kind or another.

That the passage of instruments may precipitate toxemia is granted. The danger is enhanced by uncleanliness, but strictly aseptic instruments may cause trouble. It is a question, however, whether any instrument passed through a diseased anterior urethra can be aseptic by the time it reaches the deeper portions of the canal. It is the author's firm conviction that strictly aseptic surgery of the urethra would demand a flushing out of the canal prior to the introduction of even an ordinary sound. This, we know, is not ordinarily done, nor is it always practicable. We are most of us, therefore, as a matter of routine, committing cardinal sins from the standpoint of aseptic surgery.

The various complications and sequelæ of stricture produce special and characteristic modifications of the symptomatology and course of the disease. Thus there may occur a special set of symptoms dependent upon prostatic inflammation and abscess, vesical and perivesical inflammation, urethral rupture with infiltration of urine, and the various renal complications that occur so frequently in the course of stricture.

Diagnosis of Organic Stricture.—The diagnosis of organic stricture can only be made by instrumental exploration of the canal. The facility of examination depends largely upon the condition of the meatus. It is obvious that with ordinary instruments a thorough exploration cannot be made through a narrow meatus. For example, if the canal be very large, its extreme capacity being 35 French, and stricture exists at different points, the canal being contracted at one or more of them to a diameter of 25 French, the condition cannot be readily detected through a meatus of a caliber of 20. Dr. Otis devised an instrument that has become very familiar to American surgeons for the purpose of overcoming the obstacle afforded by a narrow meatus. This instrument—the urethrometer (Fig. 50)—consists of a series of blades

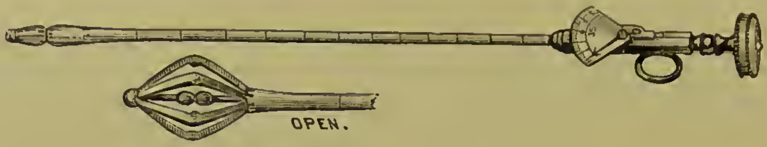

FIG. 51.—Otis's urethrometer.

operated by a thumb-screw and connected with a scale-plate or dial, with an indicator that shows the exact degree of expansion of the blades as represented by the French scale. This instrument is especially useful when an accurate record of cases is to be kept.

With the soft bulbous bougie it is possible to accomplish almost as much from a practical standpoint as with the urethrometer. After a preliminary meatotomy the canal may be explored with a series of bougies about as accurately, and perhaps on the average more intelligently and safely, than with the urethrometer. Incision of the meatus is devoid of danger if properly done, and is almost invariably beneficial in cases in which symptoms of genito-urinary irritation exist, whether stricture be present or not. The author has seen, however, one case in which considerable sloughing had followed meatotomy. This was unquestionably due to instrumental sepsis. The danger of injury by the urethrometer may be obviated to a great extent by covering the end of the instrument with a thin sheath of rubber: this does not usually interfere with the separation of the blades, but does prevent the falling of the mucous membrane between them. With some patterns of the urethrometer, when the rubber sheath is thick, the blades of the instrument are apt to twist, corkscrew fashion, as they are opened. A valid objection to the urethrometer is that by its use strictures of large caliber can be found in practically every urethra. Some nicety of judgment is therefore necessary in estimating at their true value the points of narrowing demonstrated by the urethrometer. The author believes that in quite a large proportion of healthy urethræ strictures may be detected with the urethrometer if Dr. Otis's method of examination is arbitrarily followed. This objection of course falls to the ground in cases in which there is more or less definite relation between the points of narrowing and existing pathological conditions. In such cases it makes little difference whether the points of narrowing were once physiological or not; they may have assumed pathological importance even though they be not of pathological origin.

Meatotomy should be considered as a necessary preliminary in both the diagnosis and treatment of urethral disease in any case in which the meatus is not of sufficient caliber to admit an instrument measuring at least 30 French. Some latitude, however, must be allowed, the size of the penis being taken into especial consideration. Dr. Otis adopts as his criterion of the normal size of the canal the circumferential measurement of the penis in its flaccid condition, believing that there is a constant relation between the size of this organ and the caliber of the urethra. This is probably true within certain limits, but the size of the organ is so variable at different times that it seems hardly safe to adopt this as an arbitrary rule. The psychic effect of simple sounding often causes the penis to shrink to very small dimensions. The author has had patients who claimed that the very idea of exposing the organ was sufficient to produce this temporary shrivelling. In incising the meatus due deference should be paid to its form. When the orifice is situated low down upon the extremity of the glans it cannot be incised so widely as when it is located higher up, and, as a rule, it will be found that the lower its situation the more distensible it is apt to be and the less frequently does it require incision. When practicable the orifice should be cut larger than the size which it is desirable for it to retain permanently, as some cicatricial contraction is inevitable.

Several instruments have been devised for meatotomy, the most familiar being the *bistouri caché* of Civiale. This instrument is composed of two blades, one cutting and the other blunt, separable by means of a screw. Having been introduced for a sufficient distance within the meatus, the blades are separated to the required extent and the instrument is withdrawn, incising on the way the inferior commissure of the meatus. With this instrument more cutting is apt to be done than is intended, and it is, to say the least, a bunglesome device for the performance of a very simple operation. A straight-backed, probe-pointed, narrow bistoury (Fig. 51) is the best instrument for this purpose, and in expert hands an ordinary scalpel will do in lieu of a special instrument: the scalpel may be used in combination with a director or its point may be covered with a bit of wax, thus preventing accidental injury to the canal. The incision should be made directly downward, care being taken not to cut through the floor of the urethra. Under cocaine the operation may be made perfectly painless. A 4 per cent. solution in water or an 8 per cent. oleate may be injected into the canal by means of a small syringe, and retained for about five minutes, at the end of which time the part will usually be well anesthetized.

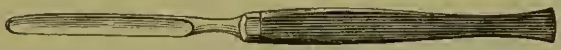
FIG. 52.—Straight, blunt-pointed bistoury.

The hemorrhage following meatotomy is sometimes considerable. The author has experienced more trouble in this respect since using cocaine than formerly. The drug not only produces local anesthesia, but also appears to produce vasomotor paresis and venous congestion; the escaping blood will be found to be dark and of a more venous hue than under ordinary circumstances. Severe bleeding is not usual, however, at the time of the operation, as the drug seems to act primarily to a certain degree as an astringent. The next act of urination, however, after the astringent effect of the drug has passed off is apt to be attended by considerable bleeding. If oozing is obstinate at the time of operation, much inconvenience may be avoided by plugging the meatus. For this purpose the author uses a wedge-shaped piece of dental spunk. This is prepared by saturating it in a solution of bichloride of mercury, 1 : 1000, and drying. This substance swells somewhat when it is wet, and plugs the meatus sufficiently to check the bleeding. Should it escape at the next act of urination, as it is likely to do, the patient should be instructed to pinch the under surface of the glans at the site of the incision with the thumb and finger until the bleeding is arrested. Dangerous loss of blood cannot occur if this be done, and the pressure will usually check the hemorrhage in a few moments. If the patient be nervous and excitable, he may become frightened by the occurrence of hemorrhage, and, losing his presence of mind, may not apply the pressure properly, as a consequence of which considerable loss of blood results. An instance of this kind occurred in the author's own practice, in which sufficient blood was lost to induce syncope. In this case he was obliged to introduce a small sponge-tent before he could finally check the bleeding. Aside from the trifling danger of hemorrhage of this character he has never seen any untoward results from meatotomy, excepting in the instance already mentioned in which sloughing of a portion of the glans about the incision occurred. Such accidents may usually be avoided by strict asepsis. The meatus should be dilated every day or two for about two weeks. Stitching of the edges of the quasi-mucous covering of the glans and the mucous lining of the urethra together for the purpose of ensuring the patency of the meatus is often of value. The author has frequently practised this with advantage.

If the meatotomy is a preliminary to treatment by dilatation, it is well to wait until the incision has healed before treating the deeper parts of the urethra. Exploration or internal urethrotomy may, however, be completed at the same operation. When the patient cannot visit the surgeon frequently, a loop of wire or a hair-pin may be bent to the required size and passed into the meatus several times daily. Careful stitching is of special service under these circumstances.

Aside from the mere fact of the existence of obstruction in the course of the canal, there are several other points that may be determined by expert exploration: this implies exploration by the urethrometer or bulbs, the ordinary sound being relatively worthless:

1. It is obvious that the degree of contraction of the stricture is quite readily determined.

2. By careful measurements the distance of the stricture from the meatus can be quite accurately estimated.

3. If the bulbous bougie or urethrometer be passed beyond the stricture and then withdrawn until it is caught, the distance of the posterior surface of the obstruction from the meatus may be determined. The space included between the two measurements corresponds very nearly to the width of the stricture.

4. The number of strictures is determined with only moderate facility with the bulbs, for the reason that the obstruction in the anterior portion of the canal may be sufficiently small to prevent the introduction of an instrument large enough to impinge upon the deeper strictures. This does not apply to the urethrometer, except in very tight strictures of the pendulous portion.

5. The condition of the urethra behind the stricture may be approximately determined by examining the secretion withdrawn from the canal on the shoulder of the instrument. When this is thick, with a preponderance of purulent qualities and containing sabulous material, the existence of a relatively pronounced degree of chronic inflammation may be inferred. When there is little or no secretion, or when such as is present is of a mucoid character, the stricture may be considered to be in a moderately passive condition and the urethra behind it comparatively healthy.

6. The degree of congestion present at the site of the stricture may sometimes be estimated. When blood appears upon the shoulder of the instrument or escapes from the urethra after its withdrawal, the exploration having been conducted with gentleness, a considerable degree of congestion at the site of the stricture may be inferred.

7. Resiliency or irritability of the stricture may be determined. These conditions are shown by the ready passage of a comparatively large sound, whereas the bulb of a much smaller bougie is obstructed. Irritability is demonstrated by the pain and spasm excited by the exploration and the subsequent occurrence of urethral chill.

After the exploration of the urethra for the first time ten grains of quinia, in combination with one-quarter of a grain of morphia, should be administered to obviate chill and fever. Diuretin has been recommended as meeting this indication. Should the patient be very sensitive or the stricture a severe one, it may be well to administer a dram of the fluid extract of jaborandi or a hypodermic of $\frac{1}{6}$ to $\frac{1}{3}$ of a grain of pilocarpine. On account of their derivative and eliminant effects these drugs are very useful, particularly in cases in which uremia is feared on account of the existence of renal disease.

The patient should be advised of the probability of pain and smarting at the next act of micturition, and also of the possibility of an increase of urethral discharge. Alkaline diluents, the balsams, and, if the stricture be severe with complicating cystitis, eucalyptus, salol, or boric acid, should be administered. No further meddling is advisable for several days after the exploration. Should urethral discharge be free, however, mild bichloride injections are admissible.

Prognosis of Stricture.—The prognosis of stricture involves two considerations: (1) Its curability; and (2) its danger to life.

The possibility of a radical cure of stricture is disputed by a majority of surgeons; indeed, the general opinion up to a recent date has been that without continual attention a stricture, once formed, will sooner or later give the patient trouble, no matter how skilfully his case may be treated. For example, it has been supposed that, as a rule, an individual who has been apparently cured of stricture during early adult life will again be troubled by the disease as he approaches middle age, unless he has in the mean time carried out more or less perfectly treatment by dilatation, the necessity for which increases with advancing age. Were it not for the labors of Dr. Otis and his disciples this old-time belief would probably never have been disputed, but through their labors it has been shown that quite a proportion of radical cures may be attained by dilating urethrotomy, providing such strictures are located in the pendulous urethra. No system of treatment that has yet been devised has been conclusively shown to produce a permanent cure of stricture of the fixed urethra, with the possible exception of a few cases of perineal section. It has been questioned whether even strictures in the penile portion of the canal have ever been radically cured, but as many cases operated upon by the Otis method have been examined upward of fifteen years after operation, and have been found healthy by careful urethrometry, it is fair to assume that in such cases a radical cure has resulted. The author bases his opinion not alone upon the claims of Otis, but upon sixteen years' experience with the operation, embracing about fifteen hundred cases of urethrotomy. This point will be expatiated upon in the discussion of urethrotomy.

It is not probable that in the instances of apparent cure by various methods, in cases in which the disease recurs sooner or later, the canal, if examined, would be found to be free from obstruction for any great length of time during the interim. If recontraction occurs after complete dilatation, rupture, or division of a stricture, such recurrence is probably discoverable by thorough exploration within a very short time after the cessation of treatment. Indeed, it will be found on careful exploration that recontraction, if it occurs at all, has usually begun within the first year following an apparent cure. For example, an individual who at the age of forty presents evidences of recontraction of a stricture that was apparently cured some years before, if carefully examined during the interim would probably have been found to have a certain degree of narrowing of the canal. There are few cases in which recontraction does not commence within six months after the cessation of treatment; but this recontraction may progress very slowly or come to a standstill until some years have elapsed. At any time during this period, however, rapid recontraction may occur as a consequence of acute or subacute inflammation excited by intemperance or sexual excesses.

A recurrence of stricture occurs much more readily in cachectic, strumous, gouty, rheumatic, and syphilitic patients than in those of a perfectly healthy constitution. Necessarily, the habits of the patient have much to do with the prospect of recurrence.

It may be formulated as a practical rule—(1) That traumatic or chemical strictures invariably recur, no matter what form of treatment may be instituted; (2) That inflammatory strictures of the deep urethra recur sooner or later, and if the urethra be carefully explored they will be found to have recontracted to a greater or less extent within a comparatively short time after the cessation of treatment; (3) That strictures of the penile urethra rarely disappear completely under dilatation, and always recur unless operated upon by urethrotomy; they rarely, however, recur, in the absence of fresh gonorrheal infection, when operated upon according to the Otis method if the operation be perfectly done.

It is usually possible to prevent recontraction of a simple stricture if we can obtain the co-operation of the patient. Strict adherence to the principles of genito-urinary hygiene, and occasional dilatation of the urethra by means of a moderately large steel sound, will generally prevent recontraction, at least to a degree appreciable by the patient.

When the patient is able to secure the services of a surgeon, it is unnecessary for him to be instructed in the art of self-instrumentation; under other circumstances, however, he should be taught the use of the sound and instructed to introduce the instrument at first once a week, later on once in two weeks, and finally once a month. When once an individual has suffered from organic stricture the introduction of the sound becomes an important item in his toilet.

The prognosis of stricture as regards danger to life varies greatly according to the duration of the disease, the severity of its complicating conditions and sequelæ, and the character of the operations undertaken for its cure. The most important factor in determining the prognosis is the condition of the kidneys. The renal structure and function are almost invariably impaired; in organic stricture of long standing such impairment is to be inferred. Pathological aberrations of the kidney are not only immediately dangerous to life—either through acute exacerbations of inflammation induced by intemperance or exposure, or by reflex inhibition of the function of the kidney produced by surgical shock in attempts to cure the stricture—but they bear an important relation to the welfare of the patient after that primary condition has been relieved. It is probable that a patient who has once suffered from secondary disturbance of the kidney incidental to organic stricture is rarely, if ever, a sound man again. His kidneys—and, for that matter, the structure composing his entire genito-urinary tract—are in a weakened, possibly degenerated, relaxed, and irritable condition that predisposes to congestion and inflammation. The slightest excess or exposure is apt to bring on acute Bright's disease of the ordinary form. Chronic nephritis may supervene at any time; pyelitis may develop after the patient is apparently cured of stricture. In brief, a patient who has once suffered from severe organic stricture possesses ever afterward a *locus minoris resistentiæ* in the direction of the kidneys, that is liable at any time to lead to serious renal disease.

Stricture may result fatally by the supervention of uremia consequent upon complete inhibition of the already impaired function of the kidneys. Retention of urine, due to inflammation of the stricture, may lead to a fatal result through rupture of the urethra or bladder, with consequent extravasation of urine, or by occurrence of acute cystitis, perhaps with gangrene of the vesical mucosa. In these conditions, secondary to retention, the patient may sink into a typhoid state and die, the condition being modified by a greater or less degree of uremic intoxication. Septicemia in its various forms may result. Debility and nervous exhaustion from pain and loss of sleep, in combination with the depressing effects of urinary intoxication or fever, are important elements in all fatal cases.

Notwithstanding the serious nature of marked types, it is surprising how rapidly some apparently desperate cases of stricture will improve when once the obstruction has been removed. Even when the kidneys are seriously impaired, the constitutional symptoms marked, and the secondary bladder changes severe, the patient often improves with wonderful rapidity as soon as the patency of the urethra has been restored. The improvement in the patient's general condition is oftentimes remarkable. The very gradual involvement of the upper portion of the genito-urinary tract in pathological conditions secondary to stricture probably explains the tolerance of the patient for severe renal and bladder-changes.

A condition not usually recognized in stricture is toxemia due to the constant absorption of ptomaïnes and toxalbumin from behind the obstruction. This toxemia has much to do with numerous little ailments of which the patient may complain, but which he rarely attributes to his stricture until the cure of the latter suggests them by the fact of their sudden and complete disappearance. This toxemia, too, constitutes a constant predisposition to urethral chill. The nervous system is loaded with toxins, so to speak, and ready for the explosion that instrumentation is oftentimes sufficient to bring about.

Treatment of Stricture.—General Management.—The successful treatment of stricture depends not only upon the proper selection of surgical methods of management and skill in their performance, but upon the manner in which the general management of the case is conducted. Careful attention on the one hand, or neglect on the other, may determine the degree of success of surgical treatment. Thus, dilatation may fail of its object because of irritability or resiliency of a stricture which attention to certain details in the general management of the case might have avoided. Urethrotomy, divulsion, or perineal section may result fatally, because of failure on the part of the surgeon to study carefully the conditions of other portions of the genito-urinary tract, and ignorance of the general and local conditions prevailing at the time of operation.

In no disease of the genito-urinary tract is attention to genito-urinary and sexual hygiene more essential than in the management of stricture of the urethra. Regulation of diet, temperate habits, sexual moderation, and avoidance of exposure to cold and wet are all-important. The use of tobacco should be interdicted as tending to induce general irritability and hyperesthesia. The author believes, moreover, that it is especially irritating to the genito-urinary tract. Chilling of the feet and legs is apt to be especially injurious, its effect upon stricture in the production of acute hyperemia and inflammation being precisely similar to its results in enlargement of the prostate, in which disease the disastrous effects of exposure are well known. The administration of alkalies for the purpose of neutralizing the urine is essential in the majority of cases. When pronounced cystitis exists, certain remedies will be found beneficial by preventing decomposition of the urine and consequently lessening its irritating properties. Oil of eucalyptus, boric acid in ten- or fifteen-grain doses several times daily, naphtol, creasote in small doses, benzoate and salicylate of soda, and small doses of turpentine are useful for this purpose. In the author's experience the oil of eucalyptus in ten-minim doses has been of especial value. The activity of the skin should be promoted by Turkish baths and rubbings. The effects of sudden atmospheric changes should be avoided by wearing warm flannel garments of uniform weight. Exercise should be taken in moderation; fatigue and over-exertion should be avoided; perfect rest may possibly be indicated.

Certain local measures are very essential in the management of stricture. A tendency to spasm and congestion at the site of stricture may be prevented by the daily use of hot sitz-baths or the occasional application of leeches to the perineum. As a matter of routine the author often advises a hot sitz-bath nightly. By proceeding in this manner it will be found that the majority of cases of stricture will be made much more tractable. In some cases of tough, resilient stricture the canal may be much more readily dilated if the patient be directed to take night and morning an injection of water as hot as can be borne. These injections should be kept up for half an hour at a time, and may advantageously be made antiseptic by the addition of bichloride of mercury, 1 in 20,000, or boric acid in saturation. Where manipulations of the canal tend to excite urethritis, hot bichloride irrigations, as recommended for chronic urethritis, may be cautiously employed. The various balsamic preparations are of service in such instances.

Pain and spasm may be excited by each attempt at dilatation, in spite of the general measures already recommended. Under such circumstances a small dose of morphia may be given hypodermically, by suppository, or by the mouth, a short time before the operation. When each operation tends to produce urethral chill or fever the administration of opium has a decidedly conservative and prophylactic effect. The author has found that in these cases of irritable stricture with a predisposition to urethral fever thorough irrigation of the canal with a hot bichloride solution before and after the introduction of a sound or before cutting operations, as the case may be, will generally obviate the difficulty. He desires particularly to call attention to the advantages of this procedure, as it will certainly tend to prevent the septic element in the production of urethral fever. Quinia, jaborandi, eucalyptus, and diuretin are probably all serviceable as prophylactics against chill, but eucalyptus is the most valuable of all.

Selection of Method.—The various forms of treatment that have been recommended for stricture are as follows:

1. Caustics;
2. Continuous dilatation;
3. Gradual dilatation;
4. Dilating urethrotomy, or a combination of section and rupture;
5. Divulsion or rupture;
6. Internal urethrotomy;
7. External perineal section or urethrotomy with a guide;
8. Internal perineal section without a guide;

9. Electrolysis ;
10. Subcutaneous section ;
11. Excision, with or without a plastic operation.

Caustics.—The treatment of stricture by caustics is a relic of surgical barbarism, and is hardly worthy of serious attention. The objects for which it was originally recommended were, (1) the destruction of the stricture, and (2) diminution of the sensibility of the mucous membrane for the purpose of allaying irritability and spasm of the canal. The substance used was generally caustic potash. Whatever the results may have been as far as temporarily restoring the caliber of the canal was concerned, the inevitable consequence of such atrocious surgery was necessarily the substitution of a chemical stricture for an ordinary organic one. As is well known, stricture due to actual destruction of tissue is the most severe form with which we are called upon to deal. All the other methods of treatment that have been enumerated have their advocates at the present day, either as a matter of routine or a variety of methods from which to make a selection, and may under proper circumstances be practised with advantage in different cases. The selection of the method is to a certain extent a matter of choice on the part of the individual surgeon. The various legitimate methods will receive special consideration after their applicability to the various forms of stricture has been outlined.

For practical purposes the surgical treatment of stricture may be divided into that of—

As regards location.

1. Stricture of the meatus.
2. Stricture of the penile urethra.
3. Stricture of the deep urethra.

As regards character.

a. Simple uncomplicated stricture.
b. Irritable stricture.
c. Resilient and elastic stricture.
d. Recurrent stricture.
e. Dense and hard, tortuous stricture.
f. Complicated stricture.
g. Traumatic stricture.

The treatment of each particular case is modified by the caliber of the contraction ; for example, in tight strictures which it seems advisable to treat by dilatation metallic instruments should not be used until a moderate amount of dilatation has been attained. The treatment is further modified by the occurrence of complications, such as false passages, retention of urine, severe cystitis and pericystitis, infiltration of urine, and abscess, fistulæ, enlarged prostate, etc.

Stricture of the Meatus.—Irrespective of their causation, strictures at the external orifice of the urethra require free division by the knife. Attempts at dilatation are absolutely useless and produce irritation. The structure of the meatus is such that it cannot be permanently stretched, and attempts at dilatation not only produce local disturbance, but also reflex irritation and spasm of the deep urethra. The proper method of performance of meatotomy has been outlined as preliminary to exploration of the urethra. Any meatus that prevents the introduction of an instrument of sufficient size to distend the remainder of the canal to its extremest capacity must be considered as strictured. As already remarked, stricture of the meatus may be a relative affair: this is true particularly of the congenital form, which assumes surgical importance only when organic or functional disease of the urethra exists behind it. In all cases of obscure nervous disturbance, with concomitant symptoms referable to the sexual organs, it is wise to perform meatotomy, for, whether apparent irritation at the meatus is present or not, the effect produced upon the nervous system is frequently very beneficial: that this effect may sometimes be a moral one is admitted; that it is not always psychic is indisputable.

In many cases of narrow meatus the urethra behind it may be demonstrated to be in a pouched condition by exploration with a bent probe. In this pouch inflammation goes on indefinitely, its perpetuation being facilitated by the accumulation and decomposition of a few drops of residual urine. Meatotomy therefore often cures a most obstinate gleet.

Stricture of the Penile Urethra.—Strictures in the pendulous portion of the urethra cause more annoyance to the patient and more perplexity to the surgeon, on the average, than those of the perineal portion, although they are less dangerous, and their direct and remote results less serious, than those occurring deeper down. They rarely contract so as to produce serious obstruction to urination, and where they form slowly we often meet with cases in which several tight strictures exist, yet have produced little or no trouble, having been discovered accidentally or during exploration for the purpose of determining the cause of an intercurrent simple urethritis. The author operated recently on a young man who had three strictures of the pendulous urethra, the tightest of which would barely admit the closed blades of the dilating urethrotome. These strictures had produced no inconvenience whatever, and probably would have remained undiscovered for some little time if the patient had not, at the suggestion of a friend, submitted himself to an examination for the purpose of ascertaining whether a gonorrhea that he had contracted some years ago had left any permanent results. Such a passive condition of strictures in this situation is of course not to be expected, for, as a rule, they give rise to frequent attacks of so-called "bastard" clap or to an indefinite perpetuation of gleety discharge.

Although strictures in any portion of the canal are apt to cause vesical irritation, the liability to this annoying symptom seems to be in direct ratio to their distance from the meatus. Comparatively slight strictures in the deep urethra will produce by direct irritation, through contiguity of structure and nervous supply and by infection of the deep urethra, annoying frequency of micturition. In occasional cases, however, this symptom is the principal feature of a stricture at or near the meatus.

The degree of contraction in penile strictures is variable. It is exceptional rather than otherwise that such strictures are so markedly contracted as those in the deep urethra. This statement may seem to be at variance with the experience of many surgeons, but the discrepancy is explicable by the fact that the majority of surgeons do not make a diagnosis in many cases in which stricture of large caliber exists. When the author speaks of the relative rarity of stricture of small caliber in the penile portion of the urethra, he means as compared with the total number of those which may be observed by careful exploration with the bulbous bougie.

Stricture of the pendulous urethra is very apt to be multiple. Indeed, there are few cases in which a full-sized bulb or the urethrameter fails to detect two or more points of contraction in different parts of the canal. These strictures are frequently irritable, and almost always resilient. They are a potent cause of chronic urethritis and gleet, and explain the obstinacy of very many apparently incurable cases of urethral discharge. Even when they are not, strictly speaking, the cause of the chronic inflammation, they invariably tend to perpetuate it. If the profession had nothing else for which to thank Dr. Otis, it would be under lasting obligations to him for his demonstration of the true pathological condition in the majority of those obstinate cases of gleet that have so long been the *bête noir* of the surgeon. When such strictures are irritable, as they are very apt to be, a very slight exciting cause is sufficient to excite urethritis, the severity of which depends upon the degree of irritation. In short, penile strictures of large caliber may be said to constitute a constant predisposition to both virulent and simple urethritis.

The more important of the conditions which, in addition to stricture, must be taken into account in estimating the causes of gleet are as follows:

1. Constitutional debility;
2. Intemperance, alcoholic and sexual;
3. The gouty and rheumatic diatheses;
4. Tuberculosis of the genito-urinary tract;
5. Chronic superficial urethritis, with or without distinct erosions;
6. Peri-urethritis with loss of elasticity, nascent stricture;
7. Folliculitis and chronic inflammation of lacunæ;
8. Cowperitis;
9. Posterior urethritis, *i. e.* prostatitis folliculosa;
10. Chronic abscesses from peri-urethral phlegmon;
11. Urinary fistulæ;
12. Neoplasms.

Admitting stricture to be the most frequent cause of gleet, the above etiological factors are still worthy of the most discriminating attention.

There is one point that should be constantly borne in mind—viz., the fact that the urethra will permit the introduction of a large-sized steel sound does not militate against the existence of stricture, for it will often be found on exploration with the bulbous bougie that one or more strictures of large caliber exist.

The tendency to irritability and resiliency on the part of strictures of the pendulous urethra constitutes the principal obstacle to successful treatment by dilatation. The author has found that dilatation in cases of stricture in this portion of the canal is usually disappointing, and that the patient either does not get entirely well of his gleet, or he apparently does so only to experience a recurrence of urethritis upon the supervention of the slightest exciting cause. He ventures the opinion that very few cases of stricture of this kind are ever thoroughly cured except by cutting, and experience has impressed upon him the necessity of radical interference and the uselessness of temporizing by dilatation. He therefore would advise urethrotomy in all marked cases and in the slighter forms where the contractions do not readily yield. When stricture is young and soft—*i. e.* of recent date and not yet fully organized—dilatation offers a good prospect of a cure, and it is but just that the patient be given the benefit of the doubt and an attempt made to cure the condition without a radical operation. In old cases, no matter if they be apparently slight, dilatation is not apt to be successful.

The prospect of cure of penile strictures by dilatation is apparently proportionate to their distance from the meatus. Strictures located anywhere between the meatus and a depth of 2½ inches bear almost the same relation to dilatation, as far as the prospect of cure is concerned, as do strictures at the meatus.

When a stricture of the penile urethra is of small or moderate caliber—that is, below 15 or 16 French—it is often advisable to begin the treatment by dilatation with soft instruments, just as would be done in stricture of the fixed urethra. If desired, the dilatation may be carried up to a point where the resiliency of the stricture begins to manifest itself; urethrotomy then becomes necessary. Some cases will apparently dilate readily at each sitting, but little progress can be made, as recontraction takes place during the intervals between the operations of dilatation. The canal may be dilated apparently to its fullest capacity, so that it will admit a large-sized sound, and the patient may be discharged, yet in a short time return to his surgeon complaining of a recurrence of urethritis. In such cases exploration with the bulbous instrument from time to time will show whether the stricture is really absorbing or not. When improvement is not steady and permanent, resiliency of the stricture may be suspected, no matter how large a sound the urethra may admit. The recourse in such cases is a cutting operation. Resiliency and elasticity are rarely met with in strictures of the deep urethra. They are, however, the rule in those occurring in the penile portion of the canal. The fact that dilatation is so unsuccessful when applied to strictures of the penile portion, as compared with those of the deep urethra, is probably explicable by anatomical differences in the location of the stricture. In some cases of stricture of the penile portion of the canal the thickening and induration occur principally in the structure of the mucous membrane proper, and just beneath it, rather than in the erectile tissue, and, moreover, the process occurs at a point of normal inelasticity of the canal—*i. e.* at a point which cannot be effectually dilated. The infiltration that occurs in deep strictures is more extensive, and is located principally in the corpus spongiosum, beneath the mucous membrane, at a point where the urethral walls are thick. It is located, moreover, upon each side of the bulbo-membranous junction, and chiefly anterior to it rather than at a point that exactly corresponds to it. The pressure of the sound produces absorption at this point on account of the thickness and succulency of the tissues and the abundance of absorbents. Stricture of the deep urethra is not so apt to be produced by strong injections as in the penile portion. Virulent inflammation is not so severe in the deep urethra, as a rule, as in the anterior portion.

When the urethral mucous membrane is severely abraded the consequent stricture is invariably tougher and more inelastic than under ordinary circumstances. Stricture of the penile urethra is very much like traumatic stricture in this respect; it will be found to be precisely like the latter, or nearly so, in respect to its amenability to treatment by dilatation.

Another point not generally recognized is the relative unrest of a stricture in the penile urethra incidental to varying conditions of blood-supply incidental to erection.

The treatment of strictures of the penile urethra may be briefly summed up as follows:

1. Those located within 2½ inches from the meatus cannot, as a rule, be cured by dilatation, and must be cut.

2. Pronounced cases in any portion of the penile urethra must be cut, either immediately or after preliminary dilatation, in by far the majority of cases.

3. The treatment of marked cases—*i. e.* those of small caliber—may be begun by continuous or gradual dilatation with soft instruments up to the size of 15 or 16 French, or even larger, and in some cases it may be advisable to continue the dilatation with soft instruments beyond this point, until the stricture shows irritability.

4. Strictures of large caliber, strictures of recent formation, and those consisting of points of normal inelasticity that are perpetuating gleet may be

treated by dilatation, the patient being forewarned that the treatment is apt to prove unsuccessful, and that urethrotomy will probably be required, either within a short time or later on, on account of a recurrence of urethritis. In other words, the patient should be informed that the treatment by dilatation, although it may prove efficacious in temporarily relieving the gleet and other symptoms of stricture, may at the same time fail to produce a satisfactory result, and that he will constantly be predisposed to attacks of inflammation from the slightest indiscretion. Should the patient be satisfied with treatment of this kind, it is hardly wise for the surgeon to insist upon an operation.

By the term "internal urethrotomy" in connection with strictures of the pendulous urethra the author means the combined operation of dilating urethrotomy according to the Otis method.

Stricture of the Deep Urethra.—Stricture of the deep urethra implies those contractions that involve "*the bulbo-membranous region.*" Strictures in this location are much more important with reference to serious secondary and complicating conditions that are directly dangerous to life than are those occurring in the anterior portion of the canal. It may be accepted as an invariable rule that the gravity of stricture is proportionate to its distance from the meatus. The structures surrounding strictures of the deep urethra are thick and vascular, and operations for their cure are a much more serious matter than in other portions of the canal. The various complicating conditions of stricture are not only most likely to arise in these cases, but they involve such important structures that the most disastrous results are occasionally produced by them. The selection of the method of treatment becomes, therefore, a question of vital importance, and in a general way it may be said that the more cautious and conservative the surgeon and the more delicate his manipulations, the more likely he is to obtain a successful result. A careful study of the case is necessary to determine the probable existence of serious vesical, and more particularly of renal, complications prior to surgical interference. The duration, condition, and caliber of the stricture and the habits and general condition of the patient must receive most careful attention, as they serve as criteria for the selection of the method of treatment.

In strictures of small caliber that have existed for a considerable time, particularly in intemperate and cachectic patients, serious disturbance of the structure and function of the kidneys is to be inferred, independently of the results of urinalysis. Even in cases of deep stricture of comparatively large caliber care should be exercised if the patient be broken down in health, is intemperate, or if the stricture is of long standing. Although in the majority of cases the danger of secondary and complicating conditions is proportionate to the degree of contraction, it must be remembered that the fibrous deposit of stricture forms and contracts more readily in some patients than in others, so that in some cases a stricture of short duration may be of very small caliber, while in others that have lasted for a much longer time there may be little contraction. Other things being equal, however, the tighter the stricture the greater the danger of renal complications; yet in cases of slow-forming stricture of large caliber the bladder and kidneys may be in a much more serious condition than in other cases of smaller caliber in which the contraction has occurred quite rapidly.

In selecting the method of treatment the surgeon should remember that no method of management of deep strictures has yet been generally accepted as yielding a permanent cure. Inasmuch as radical operations do not promise enough to counterbalance their danger, we should lean toward conservatism. If an approximately successful result can be obtained by simple and conservative measures, it is certainly unfair to subject the patient to the dangers of a radical operation.

Simple uncomplicated stricture of the deep urethra should be treated by dilatation. If the stricture be of small caliber, it may be necessary to begin treatment by continuous dilatation with soft instruments, one instrument after another being introduced in increasing sizes until the stricture is dilated as far as possible without the use of force. If a soft instrument is allowed to remain in the urethra for a few minutes, it will be found that the next larger size can, as a rule, be quite easily introduced. In cases in which a small instrument is introduced with difficulty it may be left in the canal for from six to twenty-four hours, at the end of which time sufficient absorption of the stricture will usually have occurred to permit of the introduction of a larger instrument and to permit of the passage of the urine beside the instrument while *in situ*. This is a desirable method for the treatment of some cases of tight stricture in which there are considerable congestion and a tendency to spasm, it being oftentimes rather hazardous to introduce and immediately to remove an instrument, because of the danger of spasmodic or congestive retention coming on within a few hours as a consequence of reaction. After the stricture has been dilated to a certain extent this is not so likely to occur. Gradual dilatation performed in a conservative manner, with due regard to general and local measures for the correction of general nervous sensitiveness of the patient and irritability or congestion of the lesion, will generally bring about what is practically a cure in by far the larger proportion of strictures of the deep urethra.

Anesthetics are sometimes necessary for the purpose of facilitating dilatation. In very many persons, as a consequence of nervous excitement and fear, the passage of the instrument produces so much reflex spasm that a comparatively small bougie will produce considerable bruising and inflammation at the site of the stricture. In such patients anesthetics may be required; the preliminary administration of morphine is, however, often successful. It is certainly exceptional that radical operations become absolutely necessary, for, given a patient who is able and willing to visit the surgeon or be visited by him as frequently as may be required, and an operator who has an abundance of patience as well as expertness in urethral manipulations, gradual dilatation is generally successful. The surgeon who regards the urethra as an insensate tube that is susceptible of the various operations of divulsion, cutting, and forcible dilatation without resentment is the one who is able to report the largest number of cases of radical operations for deep stricture. In direct proportion to the degree of gentleness and patience that is exhibited in the management of strictures of the deep urethra will be the success achieved in their treatment.

With all the patience, perseverance, and gentleness that can possibly be brought to bear, however, cases occasionally occur that are not susceptible to treatment by simple dilatation. In some cases the tissue of the stricture is highly contractile and elastic, and resents dilatation beyond a moderate degree, all attempts at further stretching and absorption being followed by chill, exacerbation of urethritis, or painful vesical symptoms. It may apparently dilate quite readily, and yet immediately recontract as soon as the dilatation is suspended for a time. In some patients so much pain and irritation is produced by instrumentation that it is impossible to carry out the treatment by dilatation successfully. This state of affairs rarely exists in simple strictures, but is frequently observed in those which are complicated.

The conditions requiring radical measures are—

1. *Irritable Stricture.*—In this form the patient is usually nervous and irritable and the urethra hyperesthetic. Every dilatation is attended by pain and spasm, sometimes with general convulsive manifestations, and followed by chill and perhaps fever. Such strictures are also resilient, and liable to congestion and inflammation, so that attempts at dilatation are not only unsuccessful, but it will be found impossible to pass instruments that were previously admitted with only moderate difficulty. Such strictures are usually of small caliber.

2. *Resilient and Elastic Stricture.*—Although often irritable, this form may be dilated quite readily until the urethra is apparently dilated to its fullest capacity. The symptoms, however, are not completely relieved, and on exploration with the bulbous bougie it is found that although a large-sized sound has readily passed, the stricture is still present. This condition is exceptional in the deep urethra, being more frequent in the penile portion; still, it is occasionally met with deeper.

3. *Recurrent Stricture.*—This form is really a variety of resilient stricture in which resiliency or elasticity does not immediately manifest itself. Such strictures recontract within a short time after cessation of treatment, either spontaneously or from some slight cause. As a rule, resilient, elastic, and recurrent strictures do not exhibit their evil propensities until they have been well dilated, when they become exceedingly stubborn. Very often they are of comparatively large caliber. Other things being equal, such behavior is more likely in stricture of large caliber than in one of smaller size. Like the preceding form, recurrent stricture is more frequently seen in the penile portion of the canal, although occasionally seen in the deeper urethra.

Recurrence of stricture is most rapid and certain in gouty or rheumatic subjects. The habits of the patient have a very important bearing upon this form of stricture.

4. *Very Hard Stricture of Cartilaginous Consistency and Long Duration.*—Strictures of this kind, although often traumatic, may arise from the ordinary cause—*i. e.* virulent urethritis. They are usually tortuous, and instruments are passed with difficulty. Dilatation cannot be carried beyond a moderate degree, owing to the density of the quasi-cicatricial tissue of which they are composed. Strictures of this kind will not dilate—or at least, if they do so at all, they immediately recontract—nor can absorption be induced in them by pressure. Stricture in the deep urethra involving one-half or three-quarters of an inch or more of the canal is apt to present these characteristics.

5. *Hard, Tortuous Complicated Stricture.*—Strictures of this kind are apt to be complicated by serious retention, urethral rupture, and urinary infiltration or fistulæ. There may be considerable infiltration of plastic material, not only in the urethra, but in the cellular tissue of the perineum about it. There is invariably a formation of dense fibro-connective tissue about the parts if fistulæ have developed.

6. *Cases in which Economy of Time is Necessary or the Condition of the Patient urgently Demands Relief.*—Non-resident patients who cannot afford the necessary time and expense involved in gradual dilatation must be included under this head.

Irritable, resilient, and recurrent strictures of large caliber in the deep urethra are best treated by external section, although the combined method of urethrotomy and divulsion—a relatively small nick being made in the strictured tissue, just sufficient to facilitate rupture—sometimes gives good results. American surgeons, however, are wisely giving up all cutting operations in the deep urethra with the exception of external section. When strictures of this kind are of only moderately large caliber, the tissues being relatively dense and cartilaginous, perineal section is to be preferred, although simple divulsion is often successful.

It will be found in cases of irritable stricture that the more radical operations are, on the average, productive of less constitutional disturbance than repeated attempts at dilatation. The contracted and resilient stricture-tissue is so hyperesthetic that the slightest attempt to stretch it may produce serious results; whereas division by incision or rupture relieves the hyperesthesia at once, and produces comparatively little irritation, the danger from operation being of a direct character and incidental to the possible occurrence of sepsis rather than due to any remote impression produced through the medium of reflex nervous disturbance.

The difference in the results obtained by stretching a contracted and highly sensitive fibrous structure and completely dividing it is well illustrated in certain cases of talipes, torticollis, and other conditions in which fibrous, tendinous, and muscular structures are shortened, and perhaps thickened, by interstitial connective tissue or fibrous deposit. When we find that attempts at dilatation produce severe pain and reflex spasm, with perhaps constitutional manifestations of an alarming character, further attempts at dilatation are contraindicated, and more radical measures, involving division by rupture or incision, are demanded. Complete rest for a time occasionally removes irritability, with subsequent facility of cure by dilatation.

Very hard and cartilaginous deep strictures of long standing, whether complicated or not, require external perineal section. Especially is this true of cases with serious bladder complications. The simpler varieties of complicated stricture do not necessarily call for such radical measures. In these pronounced forms of stricture divulsion and internal urethrotomy are very dangerous as well as unreliable operations. There is great danger of hemorrhage, the control of which is difficult on account of the depth of the operative lesion and the induration of the bleeding tissue, and also the special dangers of septic infection, infiltration of urine, abscess, and fistulæ, due to the tearing of the stricture and surrounding parts, these complications being favored by the heat of the tissues and the impossibility of maintaining a perfectly aseptic condition of the wound.

Internal incision of dense strictures of the deep urethra fails because it is impossible to introduce a cutting blade of sufficient size thoroughly to divide them. Indeed, in order to accomplish complete division the incision in some cases must necessarily cut entirely through the urethra. The relation of urethrotomy to deep strictures is different from that which it bears to strictures in the penile portion of the canal. In the latter the blade of the urethrotome, when properly used, nearly or quite divides the strictured tissue, which involves in many instances—and invariably in strictures of large caliber—only the mucous membrane and a more or less superficial layer of the tissues beneath it. It is of course admitted that there are many cases of penile stricture which are extensively indurated, but these are exceptions to the rule. Dittel has shown some striking cases of this kind. In the dense varieties of stricture of the deeper portion of the canal the blade of the instrument merely makes a comparatively superficial incision in the strictured tissue, and does not completely divide it. It is obvious that complete rupture of strictures of this kind cannot be accomplished without considerable injury to the structure of the corpus spongiosum. Taking these things into consideration, external perineal section is to be recommended from the considerations that—(1) complete division of the stricture is accomplished; (2) complete relief of retention is secured; (3) perfect drainage and a comparatively aseptic condition of the wound are provided for; (4) hemorrhage can be easily gotten at and subdued; (5) it is an indubitable fact that the result obtained by the operation is better and much more easily maintained permanently by occasional dilatation of the urethra than where internal operations are performed.

The author believes there is less danger, even in the comparatively slight forms of stricture in the deeper portions of the urethra, in the performance of external perineal section than in either internal urethrotomy or divulsion.

Cases demanding immediate interference on account of retention are best treated by external perineal section. If, however, the patient can be under the control of the surgeon and there is a fair prospect of a favorable result from conservative measures, the case should be temporized with in the manner that will be shortly outlined until such time as it is practicable to begin treatment by dilatation. Non-resident patients with strictures of large caliber should be operated upon by dilating urethrotomy. In certain selected and exceptional cases divulsion may be judicious. If the stricture be of small caliber, external perineal section should be performed. In some cases of deep stricture, especially when complicated by retention, electrolysis—*i. e.* galvanism—is successful as a temporary measure—*i. e.* as a preliminary to other treatment.

THE SYSTEMATIC TREATMENT OF STRICTURE BY DILATATION.

Instruments.—The instruments used for dilatation of stricture are of three varieties: (*a*) soft and flexible bougies; (*b*) fine, stiff, hair-like bougies known as filiforms; and (*c*) metallic sounds. The soft bougies are made in various patterns, the French and English varieties being most generally used. They are made in two forms—viz. (*a*) with a plain conical point, and (*b*) with an olivary tip. Their flexibility varies according to their composition. The best (or French) bougies are composed of a web of woven material covered with rubber. The plain conical form is the most serviceable. The olive-pointed variety is designed chiefly to avoid passing the instrument into any of the crypts or enlarged follicles that so frequently exist in chronic urethral disease.

In selecting French bougies it is best to choose those that are least flexible, as they are apt to be more durable and serviceable than the very flexible forms, which are so limp that they bend upon themselves when they come in contact with the slightest obstruction. The French bougies are unquestionably preferable to the English, but, unfortunately, they are not very durable. The latter variety is less flexible, but much more durable. Filiform bougies—so called because of their thread-like fineness—are composed of rubber, catgut, or whalebone. The whalebone variety is the best. The rubber variety is of the same composition and construction as the ordinary French or English bougies. Some forms of soft bougies are made with a small cap with a thread upon it, that may be fastened to a urethrotome or divulsor, the bougie acting as a guide or conductor for the larger instrument. Soft bougies of considerable length may be procured when necessary to use them as guides for cutting or divulsing instruments. The whalebone variety is stiffer and more durable than those composed of rubber, and if dipped in hot water the point may be moulded into any form that may be deemed useful for the purpose of avoiding diverticula in the urethra and to prevent the engagement of the bougie in the orifice of the stricture. When used as a guide a tunneled instrument may be passed over them. The late Professor W. H. Van Buren was the inventor of the first tunneled instruments ever used, and should have due credit for them. Some care is necessary in the selection and preservation of filiform guides. It is well to have them at least 18 inches in length. They should be smooth and perfectly straight, excepting when it is necessary to bend them for adaptation to tortuous strictures. A partial fracture of a filiform bougie is a warning to condemn the instrument. Any irregularities, inequalities, or roughness of the filiform guide are likely to catch the loop of tunneled instruments, thus obstructing their passage, and oftentimes a filiform guide is cut through.

Soft bougies and catheters are not so easily managed as stiff metallic instruments, as their flexibility permits them to bend upon themselves when they come in contact with a tight stricture. It is difficult, however, to produce injury with them, and, inasmuch as instruments should be coaxed rather than forced through a stricture, their function in the treatment of strictures of small caliber is of great importance.

During warm weather gum instruments are apt to become soft and sticky; this may be prevented by dusting them with soapstone. Care should be taken to have them perfectly free from oil before putting them away, else they will become soft and worthless. They tend to grow brittle with age, and it is not a difficult matter to break them. Measures should consequently be taken to guard against the use of superannuated instruments. In cleansing soft instruments strong solutions of carbolic acid should be avoided, for if allowed to remain in such a solution for a few minutes the polish is removed from them, and they become rough, their facility of introduction being consequently impaired.

Soft instruments may be introduced with the patient in either the recumbent or standing posture, the latter being sometimes preferable. In practising dilatation soft instruments should be used whenever a smaller size than 16 French is required. In cases of tight stricture in which instrumentation produces considerable pain and spasm the use of soft instruments is absolutely essential until the urethra has been dilated to a moderate size, after which steel instruments may perhaps be substituted.

Sounds are usually composed of inflexible metal, the steel instrument being the most popular. There is an old-fashioned variety composed of soft metal capable of being bent in any form, the use of which is very limited. There are three principal varieties of sounds. The French variety or Beniqué sound has a double curve, whose usefulness is not at all obvious.

The most important features of the steel sound are the shape and length of its point. The English (or Thompson) sound has a point the diameter of which is but slightly less than that of the rest of the instrument, it being comparatively blunt. The curve is rather long, and the point is at right angles with the shaft. Van Buren devised a modification of the English instrument that is very popular among American surgeons. Its point is smaller, more conical, and the curve shorter than that of the English instrument. The Van Buren sound is advantageous on account of its short curve, the form being such as to make the instrument easily controlled by the hand (Fig. 52). There is a disadvantage in the fact that the point is so small and conical that injury at the hands of a careless operator might be produced by it more readily than by the English instrument. As the sound acts somewhat on the principle of a wedge, it is obvious that stretching the stricture is more likely to be forced by the American than by the English instrument.

Care should be taken that the sounds are perfectly clean—*i. e.* aseptic—before their introduction into the canal. Should they become rough, they should be thrown aside or polished anew.

It is desirable for the surgeon to have a second set of sounds with a very short curve and conical point for use in the pendulous urethra. In the majority of cases of stricture it is not necessary to pass an instrument completely into the bladder in order to secure the maximum of beneficial effects from dilatation. Prostatic and vesical irritation is very often caused by the mechanical injury produced by sounds introduced into the urethra for the purpose of treatment of a stricture located several inches anterior to the neck of the bladder. There are in the market several varieties of sounds with a very short curve. After a number of years of careful study of urethral sounds the author has had an instrument constructed which he thinks is far superior to any other he has seen. The shaft of this instrument is much shorter and its point much blunter than those of the sounds in common use.

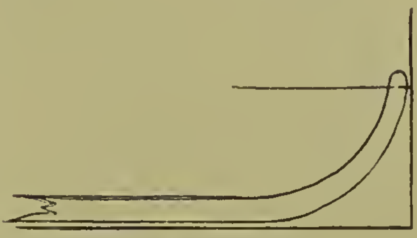
FIG. 53.—Proper curve.

The proper curve for metallic instruments, as already stated, is that known as the Thompson. This corresponds to a circle $3\frac{1}{4}$ inches in diameter. The proper length of arc of such a circle for the beak of sounds is that subtended by a chord $2\frac{3}{4}$ inches long. A shorter curve, however, enables the operator to keep the instrument under better control.

Continuous dilatation is of service in certain cases of tight stricture in which instrumentation is difficult. In cases of this kind considerable nicety of judgment is required as to the advisability of withdrawing an instrument once it has entered the bladder. The practice of continuous dilatation is certainly tempting under such circumstances, and the surgeon is excusable for hesitancy in deciding to remove an instrument that perhaps required the utmost patience and perseverance for its introduction, providing there exists any possibility of benefit if it be allowed to remain. It is usually safe to permit a small soft or filiform bougie to remain in the urethra after it has passed a stricture, and, as a rule, the effect is beneficial, for in a short time it will be found that more or less absorption has occurred, and the bougie that was previously tightly grasped has become loosened, after which it may be removed and an instrument of a larger size introduced.

The first instrument passed should be tied in the bladder and allowed to remain *in situ* for from twelve to twenty-four hours, during which time the urine may escape beside it; it certainly will do so at the end of that time. When the first instrument is removed the next larger size should be immediately introduced, as a certain degree of recontraction may occur in a few minutes and prevent the introduction of another instrument. A certain amount of urethritis is caused by the presence of the bougie, but this is rarely severe, and will subside very soon after gradual dilatation has been substituted for the continuous method. Continuous dilatation should be practised until a No. 10 or 12 French can be introduced, after which gradual dilatation should be instituted. Where it is practicable to do so a very small catheter may be passed instead of a bougie to facilitate evacuation of the bladder in case retention should occur. At the second passage of instruments, as a rule, a small catheter or bougie may be introduced, even though at the first operation it may have been difficult to pass even a filiform bougie.

The principal objection to the use of the method of continuous dilatation is the danger of cystitis. This may be obviated by daily irrigations of the viscus with a mild, warm antiseptic solution. Sloughing of the urethral mucous membrane with perineal abscess and fistula has been known to occur as a result of this method of treatment. Erichsen records a case of this kind. Such an accident could only occur as a result of extreme distention by forcibly introducing an instrument larger than necessary.

Gradual dilatation is generally the most practicable method of treatment of stricture. It should be begun on about the third day after a preliminary exploration has determined the precise location of the obstruction and the various qualities of the lesion to which allusion has already been made. It may be necessary to vary the interval following the preliminary exploration according to the amount of reaction from the latter. Much depends upon the tolerance of the urethra and the nervous susceptibility of the patient. If a preliminary meatotomy has been performed, it is often well to wait until the meatus has completely healed before going on with the treatment of the deeper portions of the canal, unless the necessity for dilatation is urgent, as in very tight strictures in which retention may occur at any time. The irritation of the raw cut surface produced by the passage of the sound over it invariably gives rise to a certain amount of reflex spasm of the deeper parts of the urethra. As a consequence irritation and inflammation of the stricture may be produced by even a small instrument.

If treatment by gradual dilatation be decided on, it should begin with the insertion of a small sound at the next sitting following the preliminary exploration, or as soon as the meatus has healed, as the case may be. The first instrument passed should be small enough to be introduced without any difficulty. In this way the sensibility of the stricture may be blunted to a certain degree, and the canal opened up, facilitating the passage of an instrument of sufficient size to distend the stricture. After the withdrawal of the small instrument a second should be inserted that is large enough to distend the stricture, but at the same time does not require force for its introduction. If pain and spasm are excited, the sound should be immediately withdrawn. If, however, the urethra tolerates its presence, it should be allowed to remain for a minute or two to secure the full effects of the distention. It should now be removed and the next larger size introduced in the same manner. It is rarely advisable to use more than two, or at most three, sounds at a single operation, a single instrument being best if the stricture be very irritable. If the surgeon undertakes to hurry the matter, he may produce severe urethritis, prostatitis, cystitis, epididymitis, or urethral fever, or cause a perfectly tractable stricture to become irritable and resilient. Any of the accidents that have been mentioned may prove a serious complication, and in addition will inevitably delay the treatment. It is the author's opinion that the surgeon is often responsible for congestion and inflammation, irritability, and resiliency of stricture occurring in the course of treatment by dilatation. One of the cardinal principles that should guide the operator is the avoidance of force, conjoined with efforts to "coax" the stricture to a cure. Nothing is gained by torturing the sensitive tissues by the introduction of too large and too many instruments.

The preliminary administration of anodynes, the continuous use of nervous sedatives and antispasmodics, and, if necessary, anesthetics, are frequently useful adjuncts to treatment by dilatation.

The sudden acquirement of a spasmodic element in a stricture under treatment may indicate renal complication. In one of the author's own cases the formation of a perinephritic abscess was heralded by severe spasm of a stricture then under treatment by dilatation.

At the next sitting dilatation should be begun with an instrument a size smaller than the largest introduced at the previous operation. Should the urethra be very irritable, it may be necessary to pass again as a preliminary measure a very small instrument for the purpose of blunting sensibility. Two sizes should be introduced as before.

The frequency of operations of dilatation should vary according to the exigencies of each particular case. Many surgeons in their enthusiasm for a speedy cure of stricture neglect to study the case carefully, and consequently introduce instruments too frequently. It is not an unusual experience to meet with cases that have been tortured into irritability and resiliency by the daily introduction of sounds at the hands of over-enthusiastic operators. While it is permissible in very tight strictures to introduce soft instruments every day, it is rarely beneficial, and usually injurious, to pass steel instruments oftener than once in three days. In many cases once in four or five days, or even longer, is sufficiently often.

Some patients will complain greatly of pain, severe spasm, and perhaps urethral chill and fever, if the sound be introduced oftener than once a week. Prolonged intervals of rest are essential in some cases.

It is necessary in all cases of tight stricture to begin treatment with soft instruments—perhaps by the method of continuous dilatation. After the stricture has been dilated to a caliber of about 15 French, steel instruments may be substituted. With steel instruments of small size there is great danger of producing injury. Such instruments do not pass of their own weight, but require a little force. The degree of pressure exerted requires some nicety of judgment, as it takes but little force to drive the point of a metallic instrument through the urethra, thus causing a false passage. In some instances it may be necessary to use soft instruments up to a considerable size before substituting sounds.

Dilatation acts in two ways: in the first instance the sound produces stretching of the stricture and temporarily increases its caliber. The next effect is absorption of the adventitious tissue. In order that this may occur it is necessary that a certain amount of reaction should follow the introduction of the sound. It is upon the increase of the nutrition of the part incidental to the slight hyperemia resulting from the mechanical stretching of the stricture that the cure depends. This reaction must be kept within bounds, for when it approximates marked inflammation the condition can only be aggravated by sounding. A slight increase in discharge following the use of the sound is usual; a marked increase is an indication that undue inflammation has been excited, and should serve as a caution against further attempts at dilatation until the parts have had time to recover.

For a short time after the introduction of the sound the flow of urine is facilitated on account of the mere mechanical stretching that the instrument has produced. This enlargement of the caliber of the stricture persists for from twenty-four to thirty-six hours, at the end of which time reaction occurs, with coincident hyperemia of the diseased tissues and an increased activity of nutrition. A moderate amount of swelling results that serves to diminish the caliber of the stricture. Within a day or two, however, absorption begins and continues for several days, at the end of which time recontraction commences. If a sound be introduced during the time the reaction is at its height, inflammation results.

As the reaction produced by the sound diminishes, the benefits of the absorption are apparent in the increased size of the stream. If the operation has been successful, the stream of urine will be larger than before. The rapidity with which reaction comes on, its degree, and the amount and duration of absorption vary greatly in different cases. A careful study of each case teaches the surgeon when another operation is desirable. If the canal be dilated in a routine manner and increasing degree every three or four days, more or less, many disappointments will be experienced. Each case is a law unto itself and should be treated upon its own merits. In some cases the urethra will not tolerate any increase in the size of the instrument for several successive operations, it being necessary to introduce the same instrument several times.

The introduction of the sound usually occasions more or less smarting and a variable degree of pain, that is most marked as the point of the instrument approaches the neck of the bladder. As it passes over this highly sensitive part more or less nausea and faintness may be produced; actual syncope not infrequently results. As already asserted, the patient should never be operated upon for the first few times in a standing posture, although it may be found to be more advantageous later on than the recumbent posture. A semi-recumbent position is perhaps most universally applicable.

Care should be taken that the instrument is well warmed and lubricated before its introduction, else pain and spasm will be greatly enhanced. The best lubricant is albolene, with the bichloride of mercury, 1 in 10,000, in combination with five to ten grains of cocaine to the ounce. Should medicated applications to the canal be required after removal of the sound for the purpose of curing a refractory gleet, glycerin should be used for the purpose of lubricating instruments. Oils coat the surface of the mucous membrane and prevent the proper action of astringent remedies applied by the endoscope or long urethral syringe.

Untoward Effects of Dilatation.—**Urethral Fever.**—Urethral or urinary fever is an omnibus term applied to certain morbid phenomena that occasionally follow operations upon the genito-urinary tract. These phenomena frequently follow simple dilatation; indeed, a slight operation is often productive of serious results in cases in which severe operations are well borne.

The greatest discrepancy exists in the statements of various authorities regarding the pathology of the polymorphous disturbances known by the various terms of urethral, urinary, and urine fever. This the author believes to be due to the fact that these terms are applied in a haphazard manner to several distinct types of disease consequent upon diseases of, and operations upon, the genito-urinary apparatus; and he is positive that a careful survey of the clinical evidence upon the subject will substantiate this opinion. Urethral fever, as the term is ordinarily used, is a "blanket" term, as broad as the mantle of charity, that comprises a series of widely-varying phenomena following chronic disease or trauma of the genito-urinary tract. Fallacious as the nomenclature of these phenomena may seem to be, we are compelled to select some comprehensive term by which they may be recognized. The term urinary fever is perhaps the most accurate. Unfortunately, however, even this term is suggestive of only one element that may act as a causal factor in the production of the morbid phenomena. Harrison has adopted this term because of his opinion that the so-called urethral fever is invariably due to morbid changes in the urine at the site of injury, these morbid changes giving rise to the development of toxic materials, which, when absorbed into the circulation, are always inimical to health and often productive of a fatal result.

It is apparent that the term "urethral fever" has been made to include conditions which bear no relation to each other, save in the fact that they have the same point of departure—viz. disease or injury of the genito-urinary tract. It is obvious that nothing else justifies the prevalent nomenclature of the various phenomena resulting from operations in this region. Surgical shock, uremia, nervous symptoms, and sepsis following operations on the urethra and bladder are entirely different conditions. It is true that these different conditions may exist in varying combinations; this does not, however, justify an omnibus nomenclature. How widely different are those cases in which death results shortly after the introduction of a sound, and cases of classical septicemia following genito-urinary operations! yet these distinctive types of disease are included under the head of urethral fever. Much of our recent knowledge of the subject is due to bacteriological studies which prove conclusively that many of the cases hitherto described as classical urethral fever are due to germ-infection or the absorption of germ-products, and should be so designated.

From an etiological standpoint the author believes we are warranted in dividing so-called urethral fever into six forms of morbid phenomena, these varieties, however, being capable of demonstration only in typical cases in each instance. They may merge one into the other, and are all secondary to genito-urinary operations, chronic disease, or injury.

1. The first form, which is by far the simplest, consists of a nervous rigor not succeeded by fever, that follows shortly after operations or injury. This nervous disturbance is, in all probability, due to slight surgical shock, with a resultant vaso-motor disturbance of the peripheral circulation.

2. Traumatic or surgical fever (ferment-fever), due to the same causes and dependent upon excessive reaction from surgical shock—perverted metabolism—in combination with decomposition of fibrin-ferments. This form of fever is quite apt to be modified by a varying degree of septic infection.

3. Toxemia following severe shock, with a resultant perverted elaboration of the urinary secretion and the formation of organic poisons similar to the vegetable alkaloids. Associated with this we have reflex inhibition of the function of the kidney with its attendant uremia, and a perversion of general tissue-metabolism. This we may term the typical form of urethral fever. It is sometimes complicated by convulsions.

4. Classical septicemia, which may prove fatal within a short time or may merge into so-called pyemia, with its characteristic circumscribed and diffuse suppurations in the various organs and tissues of the body. The latter may supervene without the characteristic phenomena of ordinary sepsis.

5. Chronic urinary fever attendent upon obstructive diseases of the urinary organs.

6. Cases of mixed type that combine in varying degrees elements of the first four forms of the disease.

If the above classification be scientifically correct, it is not surprising that the opinions of various authorities in regard to the pathology of urethral fever vary so widely. There must be some explanation for the fact that one authority claims that these varying phenomena are invariably septic; another, that they are due to ammoniacal decomposition of urine and subsequent absorption of the products; another, that they are due to simple uremia; and last, but not least, that they are due to obscure changes in the urinary secretion and the formation of new and as yet unisolated toxic compounds. It is evident to every practical surgeon that none of these causes are sufficient to explain all of the cases of so-called urethral fever. Simple absorption of healthy urine certainly will not cause the disease, nor will it even produce simple suppuration when introduced into the cellular tissue by hypodermic injection. We do know, however, that urine in a state of decomposition is possessed of most powerful propensities for evil; in fact, there is hardly any organic substance that is so destructive to the vitality of cellular tissue. There is a close resemblance between the effects of extravasation of decomposing urine and those of the poisons of erysipelas, of dissecting wounds, or even the bite of venomous reptiles, so far as their effects upon the vitality of connective tissue are concerned. It is obvious that there must necessarily be pronounced danger of septic infection in all cases of injury or operations upon the urinary organs. The injury or the site of injury is usually such that free drainage is impossible; decomposing urine is usually present, and is productive of more or less widespread death of connective and cellular tissue, and the conditions of heat and moisture are always present. Such an environment, as every biologist is aware, is peculiarly favorable to the development of those minute organisms upon which septicemia and its congeners unquestionably depend.

None of the explanations that have been given will, when taken alone, explain the fatal result which has been known to occur from the simple introduction of a smooth staff into the urethra.

There is also food for reflection in the fact that a simple straight cut in the urethra—such, for instance, as that produced in internal urethrotomy—is productive of less shock in many cases than repeated stretching of the sensitive structures of the stricture by a sound or bougie.

The cure of stricture by gradual dilatation is dependent upon (1) mere mechanical distention; (2) reactionary hyperemia, with increased tissue-change at the site of the organic deposit. The functions of the lymphatics and veins are increased in activity, and absorption takes place very rapidly. It would appear, then, that if the tissue be extraordinarily sensitive, as is frequently the case in organic stricture, and if there be present toxic principles from decomposing urine or ordinary septic materials at the site of the stricture or behind it, the operation of dilatation must necessarily be followed by a degree of nervous shock dependent upon the susceptibility of the individual and the degree of roughness of manipulation, and by a varying degree of absorption of infectious materials. The lymphatics and veins, unfortunately, have not the power of discriminating between those organic substances that are inimical to the welfare of the individual and those which can be disposed of in a physiological manner without injury to the blood or tissues, and they therefore take up the poisonous materials simultaneously with the products of retrograde tissue-change.

The relation of organic and functional disturbance of the kidneys to so-called urethral fever is a most intimate one. There is probably no case of long-standing obstructive disease of the genito-urinary tract that is unaccompanied by functional aberration of the kidneys, and in a large proportion of cases there occurs later on actual organic change in the renal tissues. This condition of affairs is to be anticipated, and should be given serious consideration in every case of chronic urinary disease. The immediate effects of the kidney difficulty may not be marked because of the activity of vicarious elimination by the skin and bowels, this vicarious action constituting the means by which the system accommodates itself to the imperfect elimination of the constituents of urine. There are very few persons, even among those who term themselves healthy, in whom the bodily sewage is perfect, and it is obvious that when the kidneys perform their functions imperfectly this condition becomes one of vital importance. When, as a consequence of operations upon the genito-urinary organs, surgical shock is produced, reflex hyperemia of the kidneys is quite apt to result. This causes a strain upon the renal circulation, which in its impaired condition it is unable to withstand, and as a consequence its functions are completely inhibited, with resultant uremia.

To those familiar with the physiology of the nervous system in its more intimate relations to visceral functions the association of renal aberration and reflex irritation will be readily understood. Many interesting examples of urinary suppression from reflex inhibition of renal function have been observed.

Peyrani has shown that the sympathetic nerves have a remarkable influence over the secretion of urine, galvanization of these nerves increasing the amount of urine and urea, while section causes both urine and urea to sink to a minimum.

The subject of autogenesis in its relations to the development of certain constitutional diseases demands more attention than is usually accorded it, and it is probable that physio-chemical researches in this direction will in future shed light upon many diseases the etiology of which is now obscure. It is probable that perverted tissue-metabolism bears a causal relation to the typical cases of urethral fever. Perverted physio-chemism may quite readily be brought about by surgical shock, this being especially marked in the glandular tissues. We know quite well that mental emotions of various kinds and those impressions upon the nervous system that result in the condition which we term "shock" may produce marked changes in the physiological secretions of the body, these changes consisting either in an increased or diminished flow or obscure chemical changes of composition; thus we may have, through various nervous impressions, an increase or decrease in the quantity of the saliva, the lacteal secretion, the gastro-intestinal secretions, the urine, and the menstrual flow.

A familiar illustration of the effect of various emotions upon physiological secretions is the change in the quality of the lacteal secretion induced by fright, anger, or grief. This change, although occult and incapable of demonstration by microscopical or chemical research, is most pronounced in its morbid effects upon the child, cholera infantum of a most fatal character being a frequent sequel to the emotion of anger in the mother. Precisely what this change in chemical composition may be is an open question, but it is possibly a species of decomposition that results in the formation of a poison analogous to the "tyrotoxicon" discovered by Professor Vaughan in impure cow's milk. It is well known, too, that sexual excitement in the cow is productive of marked changes in the milk and renders it unfit for human food.

If the changes above indicated occur in one secretion, it is highly probable that all of the physiological secretions are susceptible to them. It is possible in the case of the saliva that the emotion of anger causes the development of toxic principles in that secretion.

The difficulty of proving this theory in the present state of our knowledge of physiological chemistry is obvious. In the case of the urine the influence of surgical shock may possibly consist of the development of organic poisons in that secretion. These may be considered to be hypothetically analogous to ptomaïnes and leucomaïnes.

In some cases the development of uremia or toxemia is very gradual, and results from successive operations upon the urethra. The poisonous materials may accumulate in the system for some time, and their presence fail to manifest itself until the system is ready for the "explosion," when a previously well-tolerated and comparatively slight irritation of the genito-urinary apparatus will be sufficient to develop a serious result.

The danger of the development of urethral fever is directly proportionate to the depth of traumatic and surgical injuries of the urethra—*i. e.* their distance from the meatus. Those situated in the pendulous portion of the urethra are not, as a rule, very dangerous. The explanation of this is simple, the nerve-supply of the deep urethra being much more abundant and sensitive, the cellular tissue more abundant, and the opportunities for drainage much less favorable than in the pendulous urethra.

The relation of germ-infection, or the absorption of the products of germ-evolution, to the septic varieties of urethral fever is a most important one.

The clinical features of the various morbid phenomena included under the head of urethral fever require some special consideration:

The nervous form of the disease usually appears in patients of an impressionable constitution, or who, in other words, present a decided tendency toward neurotic disturbances. Oftentimes its occurrence may be anticipated by the behavior of the patient while he is under instrumentation. He is quite apt to have nausea, perhaps vomiting, slight rigors, partial or complete orgasm, or more or less syncope during the passage of instruments into the deep urethra. Such patients are apt to develop a sharp chill within twenty-four hours after urethral operations or injuries. This lasts for a variable time, being rarely prolonged, and then disappears, leaving the patient as well as before, with the exception perhaps of more or less mental depression. There may be a slight amount of fever or sweating. The chill may come on within a few moments after the operation.

The traumatic form is the most common: it manifests itself by a sharp chill, usually within twenty-four hours after operations or injuries of the genito-urinary tract, and is followed by pronounced fever and sweating. The disturbance either passes off after a single paroxysm or is followed by a period of general malaise, with perhaps a recurrence of the paroxysms for several days. In these latter cases a slight septic element is in all probability present.

The third form—the typical urinary fever—may or may not be attended by a violent chill coming on within twelve to thirty-six hours. There are marked prostration, violent vomiting and diarrhea, coldness of the surface of the skin at first, succeeded by more or less febrile movement if the patient survives, with suppression of urine, merging in a very short time in fatal cases into coma of an apparently uremic type. The author says "apparently uremic type," because, according to the theory already advanced regarding the action of shock upon the urine, there is probably in many cases a toxic element independent of uremia. Cases of this kind may come on gradually and manifest themselves by a sudden explosion in the form of convulsions.

The fourth or septic form of urethral fever manifests itself usually by a slight (but sometimes by a very severe) chill: this is followed by fever of varying degree of severity. The patient may sink into a typhoid condition or become comatose, and die within two to ten days from acute septicemia, or the condition may be subacute and merge into the pyogenic form of infection, known more familiarly as pyemia, in which event the patient finally succumbs to the slow development of circumscribed or diffuse purulent deposits in the joints, viscera, and other structures of the body, dependent upon infection by pyogenic microbes and their products.

The fifth or chronic form of urinary fever may be described as a chronic condition of toxemia and nervous irritation produced by long-continued obstructive and inflammatory affections of the genito-urinary tract. This condition of toxemia and general nervous irritation is one that is not generally recognized, but is very important in its relations to chronic genito-urinary disease. It exists in the majority of cases of organic stricture of long standing, in old men suffering with prostatic hypertrophy, in tumors of the bladder, in chronic cystitis from whatever cause, and in pyelitis, particularly the form due to the presence of nephritic calculus. In patients suffering with these affections there is a marked tendency to a mild form of hectic fever; flushing of the face with slight elevation of temperature, and perhaps followed by a certain degree of perspiration, is quite common; nervous irritability is especially marked. Indeed, there are few conditions that are productive of so much mental depression and irritability of temper as chronic diseases of the genito-urinary tract. In all of these cases there is apt to be more or less obscure rheumatic or neuralgic pain in various situations. After prolonged retention of urine from any cause it will be found that the majority of patients will present for a few days or weeks more or less elevation of temperature.

The different general conditions that have been outlined are due, in the author's opinion, to a toxemia dependent upon (*a*) imperfect elimination of the products of retrograde tissue-metamorphosis; (*b*) to a greater or less degree of absorption of morbific materials produced by inflammation and the decomposition of residual urine behind the site of obstruction—*i. e.* to pseudo-alkaloidal germ-products. It will be observed that many patients suffering from chronic genito-urinary disease of an obstructive or chronic character fail to realize how sick they are until the diseased condition has been removed or at least improved; they then find that slight disturbances to which they had paid comparatively little attention, and which they had never thought of attributing to their urinary trouble, have disappeared. This is due in great measure to the fact that reflex nervous irritation has been relieved, but, more than this, to the fact that absorption of poisonous materials no longer occurs.

It is obvious that the range of cases which may properly be classified as urethral or urinary fever is rather limited. Those cases resulting from septicemia and surgical shock are certainly improperly so classified.

It has been the author's experience that patients suffering from paludal poisoning are especially apt to develop chill and fever after genito-urinary manipulations.

Treatment of the Conditions usually termed Urethral Fever.—The principal measures of treatment are of a prophylactic character, for, unfortunately for the patient, the marked forms of the disease—*i. e.* the septic and uremic varieties—are seldom recovered from. The principal feature of prophylaxis should consist of strict attention to the principles of genito-urinary hygiene. If the functions of the kidney are stimulated by alkaline diuretics and the skin and bowels kept in an active condition, thus affording vicarious relief to the kidney, the patient is placed in the best possible condition to avoid those complications that have been described. In addition to these measures moderate doses of antiseptic drugs may be given internally. The best urinary antiseptic in the author's experience is the oil of eucalyptus, administered in doses of ten minims every three hours. This may be advantageously combined with salol in ten-grain doses.

Local antisepsis in cases of chronic bladder and prostatic disease is of course essential, and can be accomplished by irrigation with mild antiseptic lotions, such as carbolic acid, borate of soda or boric acid, potassium permanganate, and the bichloride of mercury. The surgeon should, if possible, avoid operation in cases complicated by structural renal disease; if operation be unavoidable, he must be very careful in his manipulations and guarded as to prognosis. Prior to operation attention should be paid to the urine and local antisepsis. The patient should be put to bed and given a milk diet and moderate doses of quinine—two to five grains three times daily—for a week or ten days.

Various drugs have been recommended for administration just before or at the time of urinary manipulations or operations. Quinine and morphine are the most popular remedies, and unquestionably increase the resisting power of the nervous system, thus lessening the liability to shock. Jaborandi is also recommended for the same purpose, and, inasmuch as its physiological action is such that it must necessarily relieve any strain upon the kidney, this drug seems to the author to be one of our most philosophical remedies. Hypodermic injections of the muriate of pilocarpine may be given instead of the fluid extract of jaborandi. In case uremia supervenes, this method of administration is absolutely essential.

The milder cases (the nervous and traumatic forms) are rarely fatal, but may possibly lead to the severer forms of the disease. The administration of opium and jaborandi, with perhaps (in the traumatic form of the disease) aconite or veratrum viride, constitutes the best treatment at our command. If uremia occurs, our attention should first be directed to the vicarious elimination of urea: valuable time may be lost in attempting to restore the functions of the kidney within the first few hours after the supervention of uremia, particularly if coma has occurred. Pilocarpine acts upon the skin even when the patient is comatose, and should be given freely. The bowels should be moved by croton oil, two or three drops of which, in combination with five or six drops of olive oil, may be placed upon the back of the tongue. If the patient is able to swallow, elaterium in doses of from one-eighth to one-third of a grain is preferable to all other hydragogues. Hot baths should be given and dry or wet cups applied over the region of the kidneys. Digitalis may be given internally as a diuretic after the emergency is over, but it is bad practice to attempt to accomplish anything by diuretics before vicarious elimination of urea has been attended to.

Urethral irrigations with solutions of bichloride 1 in 20,000 before and after manipulations of the canal will, in the majority of instances, prevent septic infection.

Measures to ensure a perfectly aseptic condition of the instruments used for exploration and dilatation of the urethra constitute an important means of prophylaxis of sepsis. Sounds when introduced should be carefully warmed and lubricated with some antiseptic ointment, and care should be taken that they are perfectly smooth.

When septicemia or pus-infection develops in spite of all precautions, little can be done in the majority of cases beyond supporting by free stimulation, a fatal result being almost inevitable. It is, however, the duty of the surgeon to attempt to avert a fatal result by incision and drainage where possible, and, if the case is clearly septic, a free incision if the stricture be perineal, or a perineal or suprapubic cystotomy in cases of bladder and prostatic trouble, is indicated.

The management of cases of chronic urinary toxemia consists in local antisepsis by irrigation and the prompt removal of the organic conditions upon which the gradual and constant septic infection depends.

Nervous manifestations due to the introduction of sounds and bearing a certain relation to so-called urethral fever are so frequently seen that they are worthy of special consideration, even at the risk of repetition of some points embraced in the preceding general discussion.

There exists in some individuals of a nervous temperament extreme hyperesthesia of the urethral mucous membrane, particularly in the prostatic portion of the canal. The nerves of sexual sensibility are apparently involved in the hyperesthesia and enter into the causation of the direct and reflex nervous results of instrumentation. Shivering, a sense of faintness, cold perspiration, and perhaps nausea are not infrequently noted during the passage of instruments into the bladder. These symptoms usually begin as soon as the instrument enters the membranous urethra, and increase as the neck of the bladder is approached. They usually pass off immediately, but may recur and constitute the nervous form of so-called urethral fever already described.

The precise cause of these nervous manifestations is difficult to determine. They are probably due in the first instance to an impressionable nervous system and timidity. They may, however, occur in individuals of strong constitution and of undoubted physical and moral courage. There is, nevertheless, no question but that a dread of the operation of dilatation has much to do with the etiology of the nervous phenomena described.

In this connection it is well to remember the intimate association of the nervous supply of the genito-urinary tract—and particularly the parts about the neck of the bladder and prostate—with the sympathetic ganglia. It is certainly true that in some individuals relatively slight disturbances of these parts produce a most profound and depressing effect upon the sympathetic nervous system, and incidentally upon all the vital functions. The modus operandi of such disturbances is probably through a reflex impression made upon the sympathetic ganglia through irritation of the nerves of sexual and general sensibility supplied to the parts involved. Conversely, it will be found that stimulation of this region within certain limits has a decidedly stimulating and even tonic effect that is beneficial to the general system. There are many disturbances of a nervous character that are purely reflex and referable to irritations of the sexual apparatus, independently of the previous existence of actual inflammation in these parts. As a matter of common experience it is noted that inflammations about the neck of the bladder and prostate are attended by relatively greater constitutional depression than similar morbid conditions of apparently much greater importance located in other situations. This is only explicable upon the theory of a reflex impression produced upon the sympathetic nervous system.

Urinary fever, and even minor disturbances, very rarely occur in women, in whom the urethra is relatively much more sensitive than in the male. Then, too, the seat of sexual sensibility is not located in this portion of the female anatomy. Erichsen states that he has only once seen symptoms of urethral chill in the female.

The liability to nervous and febrile disturbances following instrumentation of the urethra is modified to a great extent by the location of the morbid condition that is being treated. Dilatation of stricture in any part of the urethra may produce such phenomena, but they are most likely to occur after operation upon strictures in the deeper portion of the canal, not because—as has been erroneously stated by some—the deeper portions of the canal are more commonly strictured, but because these parts are more closely associated with the nerves of sexual sensibility and the filaments supplied by the sympathetic system.

Erichsen speaks of one case in which a fatal chill followed incision and dilatation of the orifice of the urethra. A case of this kind might occur as a result of reflex inhibition of the function of the kidneys produced by nervous shock. It is well known that strictures at the meatus often produce serious nervous disturbance, reflex spasm, and vesical troubles, and it is conceivable that an operation upon this sensitive part might have a very profound effect upon the nervous system in some cases. Such an effect, no doubt, might result in reflex hyperemia of the kidneys, with complete inhibition of their functions and the supervention of uremia following the purely nervous manifestations induced by the operation.

Urethral chill and fever are not very often met with unless some actual lesion of the mucous membrane exists, showing that a large proportion of these cases are due to the absorption of some toxic material.

It is well to remember that, independently of all theoretical reasoning as to the precise causation of the various forms of urinary fever, there are certainly three elements to be considered—viz. (1) An impression of a purely nervous character; (2) a condition of toxemia due to the absorption of septic materials from the affected mucous membrane; and (3) a toxic condition of the blood incidental to the retention in it of the products of retrograde tissue-metamorphosis incidental to inhibition of the function of the kidneys, and which in lieu of a better term we call uremia. These three elements may exist singly or combined.

It has been noticed that metallic instruments are more liable to produce chill and urinary fever than are the soft varieties. The only reason for this that the author can suggest is that soft instruments are used in comparatively small sizes, and their introduction is so easy that it would be a bungling operator indeed who could succeed in producing injury; whereas even in skilful hands the use of the steel sound or metallic catheter is likely to produce a relatively marked disturbance of the normal mucous membrane and of the lesion. The majority of practitioners who are called upon to introduce instruments into the urethra are by no means expert in the necessary manipulations, and are therefore more likely to produce injury with a stiff and inflexible instrument than with one that is comparatively harmless like the soft bougie.

It is to be remembered that, as already suggested, a condition of chronic uremia underlies many of the cases of rigor and fever following instrumentation of the urethra. The nervous system under such circumstances is in a perpetual state of irritability, and it is only necessary for some slight shock to occur to precipitate a nervous crisis. This shock is afforded in some instances by even the most delicate manipulations of the canal.

The occurrence of the various symptoms described may be prevented in a large proportion of cases by gentleness in manipulation and a careful study of the condition of the case at the time of each instrumentation.

The administration of anodynes, the use of hot baths, diaphoretics, and other derivative and eliminative measures of treatment, with the careful use of cocaine in mild solution and moderate quantity at the time of the operation, are very useful in the prevention of disagreeable nervous results.

The administration of morphia just before the operation in very sensitive patients, or just after it as a matter of routine until the tolerance of the patient for instrumentation has been established, is a very useful measure. Quinine, morphia, jaborandi, and perhaps diuretin, are the only remedies that are generally recognized as valuable in the prevention of urethral chill, and it is noteworthy that they are all remedies which act selectively, so to speak, upon the nervous mechanism. Eucalyptus, however, the author holds to be of great value, especially where the malarial cachexia exists. The use of hot antiseptic irrigations of the canal before and after operation in cases in which urinary fever is apprehended is a very rational procedure, as has already been suggested.

When it is found that serious nervous disturbance or urethral fever follows each operation of dilatation, more radical measures of treatment must be substituted for it. Urethrotomy in such cases is far safer than dilatation and constitutes the only feasible method of cure.

Extra sensibility of the urethra, and incidentally of the nervous system, is very frequently observed in cases in which the urethra is being operated upon for the first few times. This local and general hyperesthesia, however, becomes blunted within a comparatively short time, and after a few *séances* it will be found that the operation will be well tolerated. In some exceptional cases, however, the urethra remains permanently intolerant of instruments, and, no matter for how long a period the treatment may be continued, severe spasm, nervous shock, and perhaps rigors, will be produced by instrumentation.

Hemorrhage and False Passages.—Hemorrhage is a frequent result of the introduction of urethral instruments. As a rule, the author believes that its occurrence is an indication that undue force has been used. In most cases when the operation of dilatation is productive of hemorrhage the instrument used is too large or has been forcibly introduced. An instrument that will enter the bladder by its own weight will rarely produce bleeding, as the stretching of the stricture-tissue is accomplished in a gentle manner. In very tight strictures, and in those in which there is considerable congestion and spasm, the introduction of any instrument, however small, is liable to produce hemorrhage. When, therefore, the surgeon finds that the introduction of an instrument that will enter the bladder without the employment of force is followed by bleeding, he may infer that there exists considerable congestion at the site of the stricture. The hemorrhage, *per se*, is not injurious, but, on the contrary, is very beneficial by producing local depletion. If, however, it results from forcible catheterization, the reaction following the traumatism produced by the instrument more than counterbalances any possible benefit that might be derived from the abstraction of blood.

Some cases in which congestion exists as a predominating condition will bleed occasionally after the act of urination, and particularly if the patient has recently indulged in intercourse or has become sexually excited. Strictures of this sort are particularly apt to occur in intemperate individuals or those who have suffered from syphilis. Under such circumstances the utmost gentleness in the introduction of instruments will not prevent the occurrence of more or less hemorrhage. It is rarely necessary to treat the hemorrhage; in fact, it should be allowed to continue within reasonable limits. Should it, however, become excessive, the application of the cold-water coil or ice-bag will usually check it.

False passages more frequently result from the introduction of sounds and bougies than is generally believed. They are produced by the passage of the instrument through the urethral walls into the surrounding tissues. The mucous membrane only may be torn up, in which case the passage rarely extends for a great distance, or the corpus spongiosum may be entirely penetrated and the tissues of the perineum entered. The danger is greatest with small metallic instruments, it being rather difficult to produce injury with flexible bougies or catheters. The common English catheter with the stylet is, however, nearly as dangerous as metallic instruments.

In pack-thread or bridle strictures numerous pockets are apt to exist in the canal, or there may be a sort of membranous diaphragm thrown obliquely across the urethra in such fashion that the instrument impinges upon it just at its junction with the urethral walls, instead of entering the orifice of the stricture. Under such circumstances the conditions necessary to the production of a false passage are very favorable, and it takes but little force to perforate the urethra.

Symptoms.—The occurrence of this accident is usually quite evident at the time of operation. The surgeon is usually conscious of having used considerable force or of carelessness in respect to conforming the instrument to the natural direction of the urethra. The obstruction suddenly yields to the pressure, and the direction of the handle of the instrument demonstrates that the point is thrown out of the proper line. If the handle of the instrument be rotated between the thumb and fingers, it will be found that the point is fixed, thus showing conclusively that it cannot have entered the bladder. When the bladder is entered the point of the instrument is usually freely movable within the cavity of the organ, and there is no sense of resistance imparted to the handle when rotated.

Under exceptional circumstances the instrument may not only be forced through the urethral walls into the tissues outside it, but passed completely on until the bladder is perforated. Coincidently with the alteration in the direction of the instrument the patient complains of severe pain and perhaps a sense of impending syncope, and is apt to assert that something has been torn. Free bleeding almost invariably results. If a rectal examination be made, the beak of the instrument may be detected in the connective tissue between the vesical and rectal walls.

False passages are usually formed in the deep urethra, as it is here that the lever action of the sound can be exerted to the best advantage, and, moreover, it is here that strictures so tight as to demand the use of small instruments are usually found. It is not so easy to produce false passages in the pendulous urethra, as the point of the instrument is continually under the control of the fingers and its proper direction is easily maintained.

The danger of false passages is directly proportionate to their distance from the meatus. Their direction is usually to one side of the canal. They may, however, perforate beneath it or above it. When they occur above it, they are not likely to penetrate for a great distance on account of the firmness of the tissues. The corpus spongiosum, or even the prostate, may be completely perforated when the false passage occurs below.

The character of perforation has also much to do with the degree of danger. If the false passage enters the corpus spongiosum and runs along the urethra, perhaps to open again into the canal, or if the bladder be entered after a lateral lobe of the prostate has been perforated, the danger to life is comparatively slight. When, however, it passes clear outside the corpus spongiosum into the vesico-rectal areolar tissue, serious extravasation of urine may result, with consequent inflammation, suppuration, or perhaps gangrene of the surrounding tissues.

Old false passages are occasionally very annoying, and frequently interfere not only with treatment, but prevent a complete relief of symptoms, even though the caliber of the canal be restored. As a rule, the history justifies a suspicion of the formation of a false passage or passages at some previous instrumentation. The abnormal direction of the sound, failure to enter the bladder, and the peculiar gristly sensation imparted to the instrument are often sufficient to indicate its existence. Oftentimes the patient is aware of the presence of the false passage. Occasionally he will know that the abnormal channel has been penetrated by the instrument when its course is not evident to the surgeon. In some instances only the most careful study of the symptoms and course of the case will enable us to determine the true condition.

Acute inflammation of the urethra, prostate, bladder, and **epididymis** is a by no means infrequent complication of stricture arising as a direct consequence of instrumentation. Following dilatation of stricture there is always a moderate amount of inflammation. This reaction, however, may be limited to the stricture itself. There may occur, on the other hand, a sharp attack of urethritis. Much depends on the condition of the urethra at the time of dilatation; of more importance, however, is the degree of cleanliness and gentleness displayed in its introduction.

Inflammation of the prostate, incidental to the rough introduction of instruments, is an occasional result of dilatation. It should be remembered that the prostate is invariably congested and irritable as a consequence of the bruising to which the organ is subjected during frequent and spasmodic efforts at urination. In this condition of affairs comparatively slight traumatism may cause prostatitis. This may appear in an acute form as a consequence of a single act of violence, or it may appear in a subacute or chronic form as a result of repeated bruising and irritation. Abscess may occur, especially if trauma and infection be produced by a septic sound.

Cystitis in the course of stricture arises in several ways:

(1) It may be due to actual violence done the neck of the bladder by large instruments.

(2) It may result from the prolonged contact of instruments with the neck of the bladder in continuous dilatation. Ulceration of the bladder-walls may result from pressure produced by the point of the sound.

(3) Pre-existing chronic cystitis of the vesical neck, due to direct extension of inflammation from stricture, may be so enhanced by the irritation produced by the introduction of instruments that acute generalized cystitis and perhaps pericystitis result.

(4) A small quantity of poisonous material, formed by bacterial evolution posterior to the stricture, is carried by the point of the instrument to the deep urethra and sets up acute inflammation which extends to the bladder.

The relation of bacterial organisms—not necessarily "specific"—to the morbid processes at the site of stricture and to cystitis is a very important one.

(5) Poisonous materials—*i. e.* bacterial organisms or their products—may be conveyed to the bladder through the medium of unclean instruments.

Epididymitis is one of the most frequent complications of stricture. It may be produced in two ways: (*a*) by the production of acute inflammation at the site of the stricture, which extends down to the mouths of the ejaculatory ducts and thence to the epididymis; (*b*) by the conveyance of organic poisons to the mouths of the ejaculatory ducts *viâ* the sound or catheter.

It is desirable for patients under treatment for stricture to wear a suspensory bandage if the testes are sensitive.

These various complications of stricture may be avoided in most instances if the patient keeps quiet, is temperate, and follows directions implicitly, and, more important still, if the surgeon is gentle in his manipulations and absolutely cleanly as regards his instruments.

OPERATIVE TREATMENT OF STRICTURE.

Divulsion.—Divulsion of stricture consists of its rapid and forcible dilatation with the object of rupturing the morbid tissues. It originated, in all probability, in England, where it is still a very popular operation.

Various instruments have been devised for the operation of divulsion. Some of these consist of sliding tubes of varying caliber which are forcibly introduced over a central guide. Another variety splits the stricture after the fashion of a wedge. Still another, and the most popular variety, consists of several parallel blades separable by means of a powerful screw.

Divulsing tubes were first used by Desault about one hundred years ago. They are used in the following manner: A small bougie is introduced into the bladder as a guide; over this an open-ended catheter is passed, and over this another catheter or tube a trifle larger, as much force as is necessary being used. A succession of tubes of increasing size are passed until the urethra is dilated to its fullest capacity.

Divulsion upon the wedge principle was first recommended by Reybaud, and has been modified to a certain extent by Mr. Holt of England. Holt's instrument consists of two grooved blades of strong metal joined at their points. Between the two points and fastened to them at their point of junction is a wire that acts as a guide; over this wire a tube of considerable size is forcibly passed. This separates the blades and splits the stricture. It is claimed by Holt that the rupture produced by the instrument does not extend beyond the morbid tissue, the healthy urethra not being injured. The accuracy of this statement is certainly questionable. The author does not believe it possible for a stricture of any extent to be ruptured without injury to the urethra.

Divulsors with separable blades are the most popular instruments for the rupture of strictures.

Various patterns of the screw divulsor have been devised; they have been made with two, three, and four blades. The best divulsor is probably that of Sir Henry Thompson, which has two strong, separable parallel blades. This instrument may be used for the purpose of rapid dilatation by slowly separating the blades with successive turns of the screw, or it may be used to rupture a stricture by separating the blades as rapidly as possible. When the operation has been slowly done there is very little bleeding, and probably little or no laceration of the wall of the urethra.

Divulsion is not very popular at the present time among the leading surgeons in America. It still, however, has many advocates in England and on the Continent, where urethral surgery is far behind that of this country. The operation appears to the author to be a very unsurgical one. Unless considerable damage is done at the site of the lesion it is apt to fail of its object. Rapid stretching, unless attended by complete rupture of the stricture, will usually serve only to inflame and irritate the stricture tissue and cause it to become resilient and irritable. It is, perhaps, a safer operation than internal urethrotomy in the deep urethra, but external perineal section is safer by far than either of these operations in cases of pronounced stricture.

Resilient, elastic, and recurrent stricture of large caliber in the deep urethra may sometimes be divulsed with advantage. In these strictures gradual dilatation is usually carried on until the morbid tissue is very slight in amount and involves but a superficial extent of the urethra and the sub-lying connective tissue. Under such circumstances urethrotomy may be objected to on account of the danger of hemorrhage, and external perineal section for such slight lesions is likely to be considered severe. Divulsion under these circumstances is a useful operation. Dilating urethrotomy carefully performed may be justifiable in such cases.

The operation should be followed by gradual dilatation. A steel sound of moderate size is to be introduced four or five days after the operation, the time varying with the amount of inflammation resulting from the rupture of the stricture. An instrument should be passed at first every third day, the intervals being subsequently lengthened.

Internal Urethrotomy.—Internal urethrotomy consists in division of the stricture by cutting instruments. These are practically of three kinds—viz. (1) those which cut the stricture from before backward; (2) those which cut from behind forward; (3) those which, in addition to a cutting blade passed through a hollow central guide, have two separable blades, the object of which is to complete the operation by divulsing or tearing any of the fibers of the stricture that may still remain after the incision. The only reliable instruments for internal urethrotomy are those of Maisonneuve and Otis and their modifications. The most satisfactory instrument is the Otis dilating urethrotome.

Maisonneuve's instrument cuts from before backward, and is especially serviceable for the division of strictures of the deep urethra. It consists of a hollow tube with a slit on the side corresponding to the roof of the urethra. Triangular knives of different sizes fastened to a wire shaft are passed along this central tube after its introduction into the bladder until the stricture is divided. This urethrotome is supplied with a screw tip to which a filiform bougie may be attached. The principal objection to the use of this instrument is that it never divides the stricture completely unless a very large blade is used, in which event much more cutting is done than is absolutely necessary, and serious hemorrhage is apt to result.

The latest pattern consists of a straight tunnelled shaft with a secondary blade, the two being separated by means of a powerful screw. The cutting blade is slipped along in a groove upon the central shaft. Attached to the handle near the screw is a dial-plate. By this instrument the urethra may be cut, or dilated and cut, to a caliber of 45 French. Another modification is that of Dr. F. Tilden Brown, which consists in the adaptation of a slender

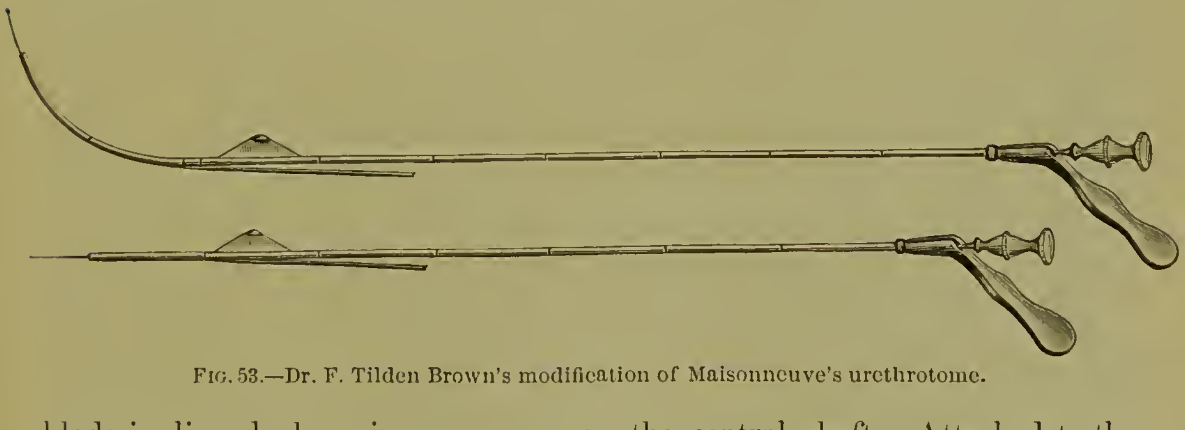

FIG. 53.—Dr. F. Tilden Brown's modification of Maisonneuve's urethrotome.

tunnel at the distal end, and of a handle set at an angle at the proximal end, of the instrument (Fig. 53).

General anesthesia is only occasionally necessary in the performance of internal urethrotomy. In very nervous patients it is perhaps essential. It must be remembered, however, that when a general anesthetic can be avoided, especially in chronic genito-urinary cases, it is well to do so on account of the possible evil effects of the anesthetic upon the kidneys. The author recognizes the fact that cocaine has something of an unsavory reputation in certain quarters, especially in urethral surgery. He believes, however, that if used in relatively weak solutions it is perfectly safe. Internal urethrotomy may ordinarily be performed with a 1 per cent. solution of cocaine in a 1 per cent. solution of carbolic acid; 4 per cent. should rarely be exceeded in the urethra. Before any surgical operation upon the urethra the canal should be flushed by solution of bichloride of mercury in a strength of 1 in 20,000 to 1 in 10,000.

Operation.—The number of strictures and the distance from the meatus having been estimated as accurately as possible, the dilating urethrotome (Fig. 54) is passed down until the point upon the shaft at which the blade will first appear when withdrawn is about half an inch behind the stricture. The blades are now separated by turning the screw until tension of the stricture is evident; the cutting blade is then to be steadily and with moderate rapidity withdrawn. The dilating blades are now separated to the required extent. They are then screwed together again and the instrument withdrawn, care being taken not to catch the mucous membrane between the blades during withdrawal. Exploration with a full-size bulbous bougie should now be made to determine whether the strictures have been completely divided. If the urethra is not perfectly free, the urethrotome should again be inserted and used in the same manner as before. The operation is to be completed by the passage of a full-size steel sound. After the operation the urethra should be irrigated with a hot saturated solution of boric acid or bichloride-of-mercury solution, 1 : 20,000. The patient should be put to bed, and if there be much hemorrhage, an ice-bag or the cold-water coil applied to the parts.

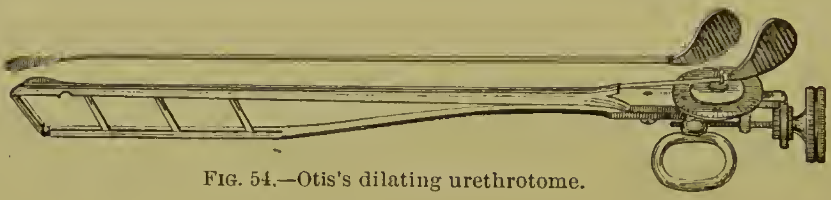

FIG. 54.—Otis's dilating urethrotome.

The determination of the size to which the urethra should be enlarged involves some nicety of judgment. The only fixed standard that has ever been advanced is that of Dr. Otis, already described. It would seem essential to repeat its essential points at this juncture. According to Otis, the average size of the urethra, as determined by numerous measurements with the urethrameter, is as follows: When the circumferential measurement of the penis is three inches the urethra should admit a sound No. 30 French. With each eighth of an inch increase in the circumference of the penis the urethra is supposed to increase one-third of a millimeter in diameter; that is, it should admit one size larger upon the French scale. Thus the circumference of the penis being $3\frac{1}{8}$ inches, the urethra should take 31; with a circumference of $3\frac{1}{4}$ inches, 32, and so on. A circumference of $4\frac{1}{4}$ inches is rarely exceeded. In such cases the urethra should admit at least 40 French. Dr.

Keyes's remarks upon this point will doubtless be endorsed by the majority of surgeons. He speaks as follows: "If the surgeon desires to enlarge the patient's stricture as widely as he can in safety, and desires a test as to the limit in size of the sound which he shall use, I know of no better ultimate limit than the scale proposed by Otis, giving it as my personal opinion that while his limit may be safely aspired to and reached, it is wiser to fall short of the standard by a few sizes, in which case all the advantages claimed by Otis will be ordinarily secured, and some of the disadvantages of a urethra unnaturally wide will be avoided."

One of the principal objections to Dr. Otis's measurements is that they are liable apparently to demonstrate the existence of stricture of large caliber at points of normal relative inelasticity of the canal. As a rule, however, there is no danger, and no disagreeable results are to be apprehended from dilating the urethra after preliminary incision to as great a caliber as is possible with the Otis instrument. Occasional cases may arise in which damage might be done.

The author believes that it is generally practicable, and, as a rule, advantageous, to enlarge the urethra as recommended by Otis where urethrotomy is necessary, but is by no means convinced that the size attained at the time of operation should be maintained by subsequent dilatation with sounds. In fact, it will often be found impracticable to maintain a caliber of more than 32 to 35 French even where the urethra has been incised and stretched to the fullest capacity attainable by the Otis dilating urethrotome (45 French). The enlargement of the urethra secured by the operation, even when the cutting is thoroughly done, is to a certain degree temporary in character, being dependent upon overstretching of the muscular fibers of the urethral walls. This overstretching makes the urethra flaccid, and for a few days a large-sized sound will be admitted; but after a time the tonicity of the urethra is restored, and as a consequence an instrument of the size which it was practicable to introduce immediately after the operation can no longer be passed without undue force. In fact, the permanent caliber of the urethra which it is practicable to secure by the operation is usually some sizes smaller than that primarily secured.

In the performance of urethrotomy the rule should be, (*a*) to make the incision downward at the meatus and a short distance within it; (*b*) to cut upon the roof of the canal in the penile urethra; (*c*) to cut downward in the balance of the canal, if at all, unless the curved Otis dilating urethrotome be used, in which event the direction of the cut must be upward.

Untoward Effects of Internal Urethrotomy.—There is sometimes considerable inflammation following dilating urethrotomy. This may give rise to chordee that may last for some little time, perhaps leaving a curvature which persists for some weeks or even months after the operation-wound has entirely healed.

There is no question that cases occasionally arise in which a greater or less degree of deformity (usually slight) results after internal urethrotomy. This has been the principal reason for the terrific howl that has been set up against internal urethrotomy by the anti-operation faction of the profession. Failure to cure a chronic gleet is frequently offered as an objection to the operation. The author is not aware of any other operation in which infallibility and absolute freedom from disagreeable results in every case operated on are demanded. Such a demand in the case of internal urethrotomy is, to say the least, decidedly unfair. A discussion at this point of the various arguments pro and con. in relation to internal urethrotomy would hardly be in good taste. The author will simply say that in seventeen years' experience with internal urethrotomy he has not only had no occasion to alter his views upon the subject, but, on the contrary, has become more firmly convinced of the solidity of the foundation upon which the doctrines enunciated by Otis were constructed.

The author has observed imperfect erection in several cases which lasted a year or more after urethrotomy. The complaint usually made is, that, while the rest of the organ becomes normally erect, the glans remains soft and flabby. This is only explicable on the ground of cicatricial interference with the circulation of the organ.

After-treatment in Dilating Urethrotomy.—The author finds that the prevailing tendency is to regard the operation of urethrotomy as a trivial matter requiring little attention to details. It is customary, for example, for the surgeon to operate at his office and allow the patient to go about as much as he pleases. This conduct the author holds to be wrong. Where possible the patient should, as a rule, be put to bed for at least a week. As an illustration of the unfairness with which the operation of urethrotomy is sometimes condemned the following is a very pertinent case: A prominent practitioner in one of our Western cities asked the author if he advocated the operation of urethrotomy. On replying in the affirmative, the practitioner informed him that he had had bad results with it, the patient dying in one instance. On inquiry the author found that the doctor was in the habit of operating at his office, and that in the fatal case the patient rode some miles on horseback to his home after the operation, and lost so much blood on the way that he died shortly after reaching his destination. It is hardly necessary to state that it was not the operation that killed this patient. Personally, while occasionally compelled to operate at his office, the author is always uneasy regarding the subsequent course of the case.

Cases occasionally occur in which there is little bleeding at the time of operation, but very free hemorrhage comes on during the night as a consequence of erection. This makes the application of cold a necessity. In one of the author's cases a very severe hemorrhage followed an erection two weeks after operation. In addition to the application of cold, anaphrodisiacs may be given after the operation. Ergot, bromide of potassium, and gelseminum meet the indications admirably. A suppository of hyoscyamus, morphia, and monobromide of camphor is of great service.

It is the author's custom to give oil of eucalyptus in ten-minim doses three or four times daily after a urethrotomy. This drug keeps the urine bland and aseptic. Boric acid, benzoate of soda, gaultheria, and salol are also of service.

It is the author's conviction that sounding is usually too vigorously carried on after urethrotomy. The danger of hemorrhage, urethritis, and curvature of the penis is directly proportionate to the frequency of dilatation after operation. The best results follow infrequent dilatation beginning on the second or third day, or even later if bleeding be profuse, and repeating the dilatation every third day for a week, and then every fourth or fifth day thereafter. There is no danger, as a rule, in allowing a stricture that has once been thoroughly cut to go for an entire week without dilatation. The cut ends of the circular muscular fibers of the urethra probably retract, serving to keep the incision sufficiently open for all practical purposes. The intermittent dilatation of the canal by the urinary outflow also plays an important rôle in maintaining the patency of the urethra.

Permanency of Result.—The claims of dilating urethrotomy as advanced by Otis and his adherents have been chiefly based upon permanency of result. The only reliable test in any particular case is a re-examination with the bulbs a considerable time after the operation. It is safe to say that in most cases of stricture appreciable recontraction will occur in a very short time—a few months perhaps—after treatment, if it occur at all. This may be disputed by those surgeons with whom the passage of an ordinary sound is a crucial test for stricture, but it will hardly be disputed by the andrologist who relies upon bulbs for his explorations. Recurrence is of course not likely to occur if systematic sounding be persisted in at regular intervals; hence old-time cases of urethrotomy in which the sound has been used from time to time will not answer our purpose in testing the permanency of the result in dilating urethrotomy. Otis, Mastin, and many others have made careful re-examinations of cases at variable periods after operation, and have found the majority of cases to be still free from stricture. As Mastin tersely remarks, it is not the number of cases, but the permanency of results, that counts for the operation. A large number of cases operated within a few months are not nearly so valuable as a few cases several years after operation.

The author has personally examined a number of cases at periods varying from one to ten years after internal urethrotomy, and has become thoroughly convinced that in by far the larger proportion of cases the operation is followed by permanent cure.

External Urethrotomy.—External urethrotomy, or perineal section, may be divided for description into two varieties of operation, which, although involving the same structures, differ as regards prognosis and facility of performance. They are termed perineal section with, and perineal section without, a guide.

Perineal section with a guide is the simpler and safer of these operations, but is adapted only to strictures permeable to instruments. The best procedure is Syme's operation. The instruments necessary for operation are a staff with a central groove (Fig. 55), a silver catheter of a caliber of 7 or 8 English, a sharp-pointed scalpel of moderate size, and a strong, broad-grooved director. The required size of the guide or staff necessarily varies according to the caliber of the stricture. It may be grooved along its entire length or only along its convexity. Syme's staff has a shoulder which impinges upon the anterior surface of the stricture, the groove in the convexity of the instrument beginning just at this point. If false passages exist, a grooved hollow staff may be used, the successful passage of the instrument into the bladder being indicated by a flow of urine.

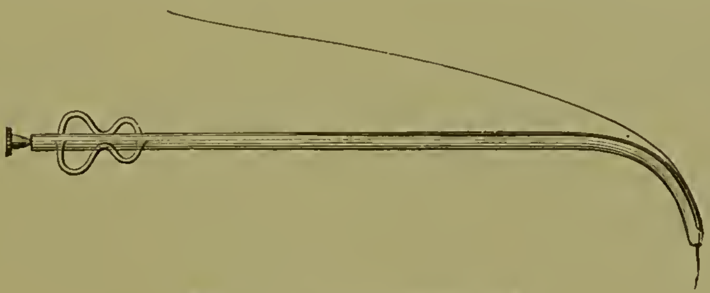

FIG. 55.—Gouley's catheter-staff.

Operation.—The patient, having been anesthetized, is put in the lithotomy position, with feet and hands fastened together with lithotomy anklets or ordinary roller bandages or held by assistants, and the staff or guide is passed through the stricture into the bladder. The perineum should be scrubbed thoroughly and bathed with alcohol or bichloride solution 1:1000. The operator, seated in front of the patient, now enters his scalpel, with the cutting edge of the blade upward, into the raphé of the perineum one-half to three-fourths of an inch in front of the anus; an upward dissection of about an inch and a half is now made until the urethra is exposed, when the knife is made to enter the groove of the staff behind the stricture, after which the latter is thoroughly divided from behind forward. The staff is now withdrawn, and a good-sized sound is passed into the bladder to demonstrate that the canal is perfectly free. A soft catheter or the silver catheter before mentioned should now be passed into the bladder and tied in for twenty-four hours. There are several varieties of drainage-tubes that are excellent substitutes for the catheter. At the end of from four or five days to a week gradual dilatation must be commenced, sounds being introduced every third day at first, later at less frequent intervals. The urine escapes by the perineal wound for some little time, but healing gradually occurs and the urine flows through its normal channel. Fistula is a rare result; sooner or later the track of the wound closes spontaneously. Incurable fistula is rare.

The rules for the operation as outlined by Syme are essentially as follows:

1. Be positive that the staff or guide has really penetrated the stricture and entered the bladder, this caution being especially necessary if false passages exist.

2. Take care not to deviate the incision from the median line. In this location a sort of septum exists even in the deep perineal tissues. As long as the incision does not deviate from this line there is little or no danger of injuring any vessel of considerable size. The principal vessel that is in danger is the artery of the bulb, but this need not be cut, as a rule, if the incision is carefully made in the raphe.

3. Keep the edge of the knife mainly upward to avoid opening the posterior layer of the deep fascia of the perineum, with consequent danger of infiltration of urine into the pelvis, with serious inflammation and perhaps gangrene of cellular tissue.

4. Insert the point of the knife posterior to the stricture, and incise it by cutting from behind forward in the groove of the guide. (This is not always practicable.)

5. There is sometimes considerable trouble in passing an instrument into the bladder after the stricture has been cut. This may be obviated by inserting a director with a broad groove into the posterior portion of the urethra after the stricture has been divided and before the withdrawal of the staff. The grooved director is turned upward in such a manner that as the sound or catheter is passed through the canal its point is directed past the incision into the bladder.

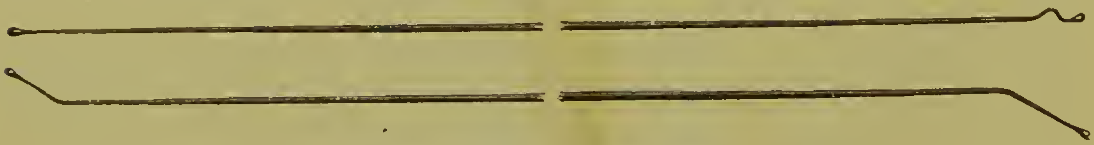

FIG. 56.—Filiform whalebone bougies.

In cases in which it is difficult to insert the ordinary grooved staff a filiform bougie (Fig. 56) may be passed into the bladder and Thompson's dilator threaded upon it. With this instrument the stricture is expanded until it will readily admit the staff. A tunnelled staff (Fig. 57) may, however, be used, being forced into the bladder over the bougie as a guide.

Perineal section without a guide is one of the most troublesome and formidable operations in surgical practice. Some of the most skilful surgeons who have attempted the operation have failed in its accomplishment. Others have succeeded only after a bunglesome, tedious, and prolonged search for the urethra. It is a very fortunate circumstance that such operations are at the present time very rarely necessary of performance, for the reason that if the surgeon be patient and administers an anesthetic he will usually succeed sooner or later in passing an instrument through the stricture and into the bladder beyond it. No matter how small the instrument may be, it is an accurate guide to the course of the urethra. Once an instrument is passed (even if only a filiform bougie) into the bladder, the case is practically under control, as a tunnelled staff can be threaded over it and pushed through the stricture, the operation being then completed as in ordinary perineal section.

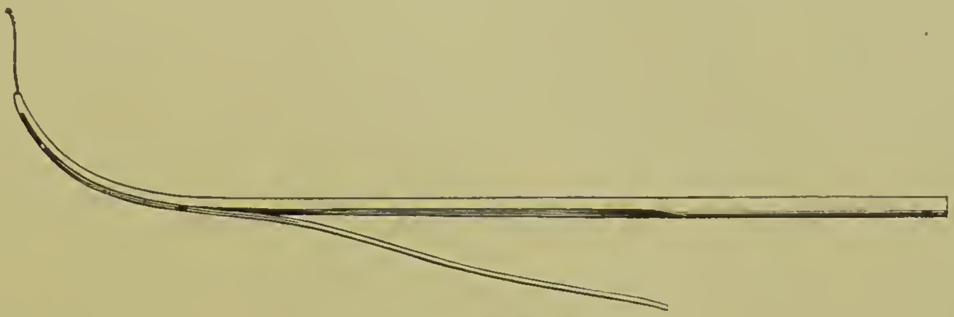

FIG. 57.—Tunnelled sound.

The practicability of instrumentation, therefore, determines the safety of the operation of perineal section. Cases are rare in which operation without a guide is necessary, for a period of temporizing, no matter how prolonged, is better than proceeding at once to so serious a measure as section without a guide. Electrolysis may be tried if all other means of penetrating the stricture fail.

In considering the operation of perineal section without a guide we must admit that, although exceedingly rare, cases of practically impermeable stricture may be met with. These may be termed surgically impermeable. Complete obliteration of the urethra can only be produced by injury or sloughing of the mucous membrane and corpus spongiosum from some cause. Even in cases in which fistulæ coexist with an old and indurated stricture the urethra is rarely impervious to either instruments or urine. It is conceivable, however, that it might become so as a result of diversion of the urine from its normal channel by a fistula, providing some lesion of the mucous membrane had existed that was capable of furnishing inflammatory exudation.

It is nothing unusual for the surgeon to discover at the time he proceeds to make the perineal section that anesthesia has relaxed the parts, so that an instrument of moderate size may be readily introduced. Whenever, therefore, such operations are determined upon, an attempt should be made to pass instruments after the patient has been anesthetized, in the hope of either providing a guide for the cutting operation or paving the way to treatment by dilatation, the rule being that when a stricture is permeable to fluid it is not impermeable to a bougie. It must be acknowledged that there are occasionally exceptions in which the urethra has become so tortuous and contracted, and the tissues of the perineum so indurated by inflammatory deposit —perhaps occurring as a consequence of extravasation of urine—that no instrument can be passed, although urination can be performed with comparative facility. In cases of this kind a perineal section without a guide may be necessary.

Operations begun without a grooved guide or the insertion of a bougie to indicate the line of the urethra may often be completed with a guide after the anterior surface of the stricture has been exposed, a filiform bougie being passed through the latter.

Operation.—There are two ways in which perineal section without a guide may be performed: (1) The urethra is opened in front and the stricture is divided from before backward. What is known as the Wheelhouse operation is the best method for this procedure. (2) The urethra is opened posterior to the stricture, and the latter is divided from behind forward. The first method is the preferable one, the classical procedure being the *boutonnière* (button-hole) operation. A sound or catheter of moderate size is passed down to the face of the stricture. It is then turned around so that the point of the instrument projects in the perineum in front of the stricture. An incision about an inch and a half long is now made directly down upon the point of the instrument until the urethra is exposed. A small incision is then made into the latter just in front of the stricture, and the sound hooked up into the angle of the wound. A ligature is passed through each side of the incision and given to an assistant; these, in conjunction with the hook-like action of the staff, serve to hold the lips of the wound apart and facilitate inspection and exploration of the stricture. A special angular, hook-like staff is used by Wheelhouse in this maneuver. After the hemorrhage has been checked the opening through the stricture will usually be readily seen. A fine probe or small director is slipped into this if possible, and a fine-bladed tenotome is passed along the guide so as to divide the strictured tissue. Great pains should be taken to search for the orifice of the stricture, for if a filiform bougie or bristle can be passed through it, the operation is greatly simplified, the danger of the operation being that the surgeon will lose the urethra, and in his aimless efforts to find it severe or even fatal hemorrhage may be produced. The author recalls a case of this kind in which a very capable surgeon experienced so much hemorrhage in the operation that the patient died within a few hours. In another case he completed an operation after an experienced surgeon had failed to find the urethra after two hours' search.

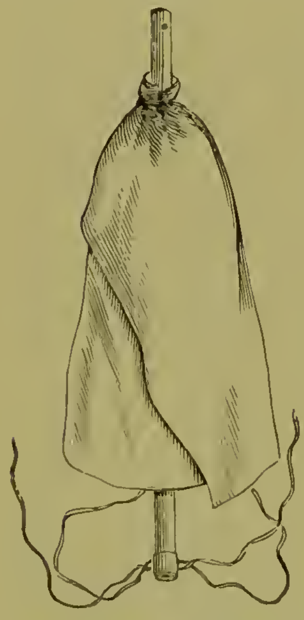

FIG. 58.—Shirted cannula.

Should it be impossible to pass a guide through the stricture after its anterior surface has been exposed, the urethra may be opened up posterior to it and an attempt made to pass a probe or bougie from behind forward. Failing in this, a dissection must be made from before backward in the normal direction of the urethra. In a case of this kind the author would be inclined to perform suprapubic section and retrograde catheterism. This procedure has on several occasions been invaluable to him.

After the stricture has been freely divided a good-sized sound should be passed into the bladder to demonstrate that the passage is clear. The sound is then removed, and a catheter passed and tied in as in the operation with a guide. The sound should be passed at proper intervals, as after the ordinary operation of perineal section.

Instead of passing a catheter through the entire length of the urethra and allowing it to remain in the bladder after the operation of perineal section, perineal drainage is excellent. This comprises the passage of a large soft-rubber catheter into the bladder *viâ* the wound in the perineum. This is tied in and allowed to drain into the urinal. It may be removed in two or three days. Such a drainage-tube facilitates washing the bladder and the perineal wound with antiseptic solutions and prevents infection.

Hemorrhage after perineal section may usually be controlled by pressure. If venous oozing be free, the wound may be packed with styptic cotton. Irrigation with very hot water is often efficacious. When the bleeding is obstinate a petticoated or "shirted" cannula (Fig. 58) may be introduced, as in bleeding after lithotomy. In one case the author found the following device to act very well: A stiff gum catheter was passed through an ordinary condom and into the bladder. The condom was then blown up by a small catheter introduced into the outer end, and tied firmly about the catheter left in the bladder, so as to prevent the air escaping. By this device sufficient pressure was secured to stop the hemorrhage. A perineal crutch may become necessary.

One word of caution to the operator may not be untimely. He should begin his operation, if possible, early in the day, and be sure and secure plenty of light. A dark day and a hurry have been fatal to not a few patients in the practice of different surgeons.

COMPLICATIONS AND RESULTS OF STRICTURE.

False Passages.—False passages are rare occurrences in the practice of surgeons who exhibit the necessary patience and gentleness in the introduction of instruments. They are rarely caused by the use of large instruments in the ordinary performance of dilatation, and are very exceptionally produced by other than metallic sounds and catheters.

Forcible instrumentation was formerly occasionally practised for the purpose of relieving retention. A catheter was passed down to the face of the stricture and forcibly crowded on in the direction of the bladder. Very rarely indeed did the instrument pass through the stricture. More often it was forced entirely beyond the urethral walls and passed along in the cellular tissue. Once in a while the operator succeeded in reaching and evacuating the bladder. The result of such surgery was the frequent occurrence of false passages. When an instrument is passed in this manner it may enter an enlarged follicle of the urethra and produce rupture at that point. More frequently the instrument enters a pocket in the anterior surface of the stricture, the false passage taking its point of departure at this spot. The signs indicating the occurrence of this accident have already been enumerated.

Treatment.—When the surgeon suspects that a false passage has been made, he should practise strict non-interference for a couple of weeks unless retention exists. Further attempts at instrumentation will only result, in all probability, in a chronically indurated condition of the false passage. There will at first be slight hemorrhage from the urethra, and within a few days more or less purulent discharge. As a rule, the passage will be found to have closed within two or three weeks. It may, however, in spite of conservatism, become chronic. Such accidents as urinary fever, infiltration of urine, abscess, and fistula are occasional results of accidents of this kind.

In passing instruments into a canal in which a false passage is known to exist great care should be taken to avoid entering it with the instrument. The oftener such a passage is dilated the longer will it persist, and it may become absolutely incurable if such manipulations are persisted in. The deviation in the direction of the instrument, the sensation imparted to the hand, and the patient's own subjective sensations usually indicate the position of the instrument. A careful study of the case is necessary to determine the location of orifices of old false passages. As a rule, the instrument engages in the orifice of a false passage much more easily than in that of the stricture, and the comparative facility with which the instrument is passed into an abnormal channel may mislead the surgeon into the notion that he is dilating the stricture. A false passage may sometimes be avoided when its location has been determined. It may be necessary, when an instrument has once been passed into it, to allow it to remain *in situ*, other and finer instruments being passed in the hope of engaging one in the orifice of the stricture proper. The expedient of filling the urethra with filiform bougies is sometimes successful, one or more instruments finally passing the stricture. An excellent plan, and one which has been very useful to the author, is to pass an endoscopic tube down to the face of the stricture, a filiform being passed through it and an attempt made to enter the proper channel; if necessary the tube may be filled with the filiforms. When once an instrument is passed through the stricture it should be allowed to remain *in situ*, and the stricture either dilated to a moderate extent by a Thompson's dilator slipped along a filiform guide or treatment by continuous dilatation begun. If it is found impossible to pass instruments through the stricture and retention exists, aspiration above the pubes should be performed, while attempts at instrumentation are still persisted in.

The best operation for stricture complicated by false passages is external perineal section with a guide. Should it be absolutely impossible to introduce a guide, it is necessary to operate without it.

Retention of Urine.—Retention of urine is the most frequent complication occurring in stricture of the urethra. In all cases of stricture of small caliber the patient is constantly menaced with the danger of practically complete closure of the urethra incidental to spasm or congestive and inflammatory infiltration—*i. e.* plus conditions—at the site of the lesion. The liability to this accident is greatly modified by the constitutional condition of the patient, his habits, and, what is quite as important, the delicacy of the manipulations instituted for the cure of the disease. Chilling of the feet and legs, indulgence in alcoholics even to a moderate extent, over-eating, and sexual excitement with or without gratification are the most frequent exciting causes.

When retention of urine becomes complete the bladder soon becomes distended to its utmost capacity, and perhaps yields to the pressure of the contained fluid until it fills a large portion of the abdomen; as a result of this distention there are considerable pain and constitutional disturbance. It now becomes urgently necessary to speedily evacuate the bladder. If this be not done, overflow may occur after a time or the urethra will yield posterior to the stricture, with consequent extravasation of urine either in front of or behind the triangular ligament. Gangrene of the cellular tissue with profound prostration, a typhoid condition, and usually death, will ensue if the extravasation be extensive, or in more fortunate cases an abscess may form that subsequently discharges and leaves a fistula. In long-standing cases in which the bladder is dilated and sacculated, rupture of the bladder itself may possibly occur with an inevitably fatal result. After an attack of retention the bladder is always left in a much worse condition than before, and perhaps may remain in a more or less acutely inflamed state.

Treatment.—It is well to avoid the passage of instruments at this time where it is possible to do so, as the contact of a catheter with the inflamed area is apt to increase the irritation. Antispasmodics should be given and the patient placed in a full hot bath. Morphia may be given by the mouth or hypodermically until the full narcotic effect of the drug is produced. If these measures fail, an attempt should be made to pass a small catheter. Contrary to what might be expected, an instrument sometimes passes through a stricture more easily where retention of urine exists than under other circumstances. This is probably because a slight degree of absorption of the indurated tissue occurs as a consequence of the inflammation. In addition, it is probable that the pressure behind the obstruction serves to stretch the stricture apart to a slight extent, thus facilitating the entrance of an instrument. If necessary, an anesthetic should be given. Attempts at catheterization are not complete until anesthesia has been produced. The surgeon should never despair of being able to introduce a catheter until he has failed with the patient under an anesthetic. If a catheter cannot be introduced primarily, a filiform bougie may possibly be passed. This should be left in the bladder for some time, and if when it is withdrawn the urine does not flow, as it is likely to do, a small catheter may usually be introduced. When once an instrument has been passed the case is under control. The instrument should be tied in the bladder. Leeches may now be applied to the perineum.

Free catharsis by means of salines usually benefits in a derivative manner. Derivation may also be produced by the hypodermic injection of pilocarpine.

Should it be impossible to relieve the retention *viâ* the urethra, it is usually wise to temporize by the employment of an aspirator in preference to operations of a radical character. In by far the majority of cases the urine will flow by the natural channel a short time after the distention of the bladder has been relieved by the aspirator. Should this not occur, however, the aspirator may be again used, and if necessary a number of times, the surgeon meanwhile proceeding with his antiphlogistic and derivative measures and cautious and gentle attempts to pass an instrument.

Should the surgeon be unable to see the patient frequently, it would be well after the introduction of a filiform bougie or small catheter to pass a tunnelled Thompson's dilator over it as a guide, the stricture being moderately stretched. Divulsion and internal urethrotomy are not to be recommended at this time, as a rule. The passage of a catheter for the relief of retention should usually be considered as the commencement of treatment by continuous dilatation.

Where other means fail it may be advisable to perform section without a guide.

Infiltration of Urine.—Infiltration of urine is perhaps the most serious complication of stricture of the urethra. It may occur in any one of five ways:

1. As a consequence of rupture of the urethra or bladder incidental to prolonged retention.

2. By rupture of the dilated and ulcerated point of the urethra behind the point of obstruction from prolonged and violent straining efforts at micturition.

3. By laceration of the urethra due to over-distention of the canal produced by the passage of large sounds. In this instance infiltration occurs at the next act of urination.

4. Division or rupture of the urethra incidental to the operations of internal urethrotomy or divulsion.

5. Burrowing of urine between the layers of the tissue about the margins of the wound produced by external perineal section.

Infiltration of urine occurs in three forms: (*a*) Escape and extravasation of urine into the cellular tissue of the pelvis, as a consequence of rupture of a dilated, thinned, and sacculated bladder. (*b*) Rupture of the urethra within the confines of the deep layer of the superficial fascia of the perineum or Buck's fascia. (*c*) Infiltration produced by rupture behind the triangular ligament or deep perineal fascia.

The most common method of extravasation of urine is the giving way of the urethra immediately behind the stricture. This structure, already thinned and dilated, becomes over-distended, and eventually ulceration occurs at some point, usually upon the floor of the canal. As a consequence of retention of urine or straining efforts at micturition, a few drops of urine escape into the surrounding cellular tissue, and an extension of the ulcerative process immediately begins, with perhaps more or less sloughing of the tissues. As a consequence, the trifling aperture in the urethral floor becomes enlarged, and in a short time the urine escapes in considerable quantity into the cellular tissue of the scrotum, perineum, groin, and, if Buck's fascia gives way, the thighs. In some instances the dilated follicle in the urethra becomes acutely inflamed, as a consequence of which its duct becomes occluded. Within the follicle a drop of urine is retained with the products of decomposition and inflammation. After the closure of its duct this little pseudo-cyst becomes distended with pus and the irritating products of urinary decomposition. Under these circumstances it is apt to give way, either into the urethra or externally. Should it give way externally, extravasation of urine may not occur, the process remaining as a folliculitis or, if more extensive, a periurethral phlegmon. The abscess may be quite extensive. If the contents of the dilated follicle escape back into the urethra, an opening is thus afforded to the passage of urine. Later on the follicle ruptures as a consequence of over-distention, and abscess occurs. Fistulæ may result from such abscesses. In some instances an abscess ruptures externally and subsequently opens into the urethra. Under such circumstances serious extravasation of urine is not apt to occur, the entire extent of the fistula having become lined with a pseudo-membrane that protects the surrounding tissues from burrowing of urine. In other instances rupture of the urethra occurs, with the formation of an abscess or sloughing of the tissues; the process finally appears externally, and a fistulous opening into the urethra is thus immediately established. The slower the process of infiltration the more apt it is to be confined by inflammatory exudate, which acts in a conservative manner by preventing serious infiltration.

The slighter forms of infiltration of urine may occur in any portion of the urethra and produce folliculitis, periurethral phlegmon, or abscess and fistula. When general extravasation of urine occurs, the portion of the canal that usually gives way is the membranous urethra between the layers of the triangular ligament. At this point the walls of the canal are rather weak, there being a lack of support by the tissues about it. It is at this point also that dilatation and thinning are most apt to exist, the location of the obstructing stricture being most frequently at the bulbo-membranous junction. Strictures anterior to this point are more often of comparatively large caliber, and are not apt to lead to those conditions which predispose to or excite general extravasation. The infiltrated urine finds its way after a time through the anterior layer of the triangular ligament at the point where it is penetrated by the urethra. It is now beneath the deep layer of the superficial fascia of the perineum—*i. e. within the confines of Buck's fascia;* this fascia, as long as it is intact, subsequently guides the course of the urine. This structure, it will be remembered, is attached to the anterior layer of the triangular ligament in the perineum, and laterally to the rami of the ischia and pubes as far upward as the pubic spine, where it becomes continuous with the deep layer of the superficial fascia of the abdomen. This latter fascia in its turn is attached anteriorly along Poupart's ligament as far as the crest of the ilium. The infiltrated fluid, therefore, invariably takes a direction, first, forward into the perineum and scrotum, and, second, upward upon the genitalia and the anterior abdominal wall and outward along the groin upon either side. Were it not for the limitation of the extravasation by Buck's fascia, the fluid would be governed by the force of gravity, and pass backward and downward, extravasating about the rectum and down the thighs. Should Buck's fascia give way, the infiltrated urine may gravitate backward, and may also appear laterally upon the thighs.

The effects of infiltration of urine are two—viz. general and local. The general symptoms are from the first, in some instances, of an asthenic and irritative character. Even in the strongest patients extensive infiltration is soon succeeded by a condition of asthenia with typhoid symptoms, low muttering delirium, dry brown tongue, sordes, and finally coma and death. If the treatment is unsuccessful in relieving the infiltration in cases in which the infiltration is limited, an abscess results with the same symptoms as are observed under ordinary circumstances, with the exception perhaps that there is more marked prostration.

The local effects of infiltration of urine are very marked. The results of infiltration of urine are not those of contact of urine *per se*, but of urine which has become vitiated by decomposition and the addition of the products of inflammation. Perfectly normal urine has been shown to be harmless when injected into the cellular tissue.

When urine is infiltrated into the perineum and about the genitals, the effect of the irritant poison is immediately manifest wherever the areolar tissue is touched by the fluid. A diffuse cellulitis is set up, and the tissues are converted into dark, pultaceous, stringy sloughs, mingled with fetid pus of a dark color and decomposing ammoniacal urine. If the urethra gives way suddenly, the irritant fluid is forced into the tissues for some distance in and about the affected portion of the canal. Under these circumstances the destruction produced is very extensive. The scrotum may slough, leaving the testes absolutely bare. The patient is likely to die before this occurs, however, so that such a condition is rare. In some cases the extravasation occurs more slowly, as has already been indicated. A few drops of the irritant fluid escape from the canal through a slight solution of continuity in its coats; this gives rise to inflammation of a phlegmonous character in the tissues about the urethra that limits for a certain time, and perhaps indefinitely, the progression of the extravasated fluid. This inflammation usually causes an abscess which may break internally or externally and be followed by general extravasation or fistula. When extravasation is rapid and extensive the perineum becomes brawny, and finally boggy, the scrotum distended and edematous, the parts presenting a dusky or purplish-red color; the tissues speedily become gangrenous.

If the patient is able to resist the depressing effects of the extensive destruction of tissue, repair may be very rapid. The reparative power of the parts is certainly remarkable, and is noted not only in these cases, but in phlegmonous erysipelas and cellulitis affecting this region. The extravasation rarely extends farther than the groins and lower part of the abdominal wall, but has been known to reach the level of the ribs. When in retention of urine the urethra gives way between the layers of the triangular ligament, a sense of relief is experienced by the patient, with a sensation as though the tissues had ruptured in the perineum, this being attended perhaps by more or less pain. The symptoms may be obscure for some little time, and very little swelling may occur, but in a few hours, or perhaps not for a day or two, a sense of heat, throbbing, or lancinating pain and burning will be experienced in the perineum; later on, a boggy, diffuse, purplish-red swelling appears in the perineum and scrotum and extends forward very rapidly.

When the infiltration takes place entirely behind the triangular ligament, a similar sense of relief is experienced, but the symptoms are subsequently even more obscure. After a time, if the patient survives, deep, throbbing pain will be experienced, with perhaps swelling of the perineum. Examination per rectum may detect the boggy fluctuation characteristic of infiltration. In cases of rupture posterior to the ligament the fluid is likely to burrow into the pelvis and about the rectum and prostate, and destroy life without any positive external manifestations.

Infiltration from rupture of the bladder is one of the rarest forms of complication of stricture. Its method of production and effects, although more obscure, are almost precisely identical with infiltration from rupture of the urethra. If the bladder be tolerably healthy, retention of urine is not likely to produce rupture unless traumatism be superadded. A fall or blow upon the abdomen may produce it under such circumstances. Relief is usually afforded by rupture of that portion of the genito-urinary tract which offers the least resistance—*i. e.* the dilated and diseased portion of the urethra behind the stricture—or by overflow. A certain amount of urine may escape by distention of the diseased portion of the urethra, although the bladder cannot empty itself. In some cases overflow occurs as a consequence of subsidence of the inflammatory and spasmodic elements of the obstruction. By this time, however, the bladder has become so atonied by over-distention that it cannot empty itself. When the bladder is ulcerated, as it may be when a calculus complicates stricture or an instrument has been allowed to remain in contact with the vesical walls for a long time, the bladder-walls may yield at the weakened point. In cases of extreme dilatation and sacculation of the bladder the walls of the viscus are apt to yield to the pressure of the contained fluid at the point of least resistance—*i. e.* the thinnest and usually the largest sacculi. When rupture of the bladder occurs the urine escapes into the cavity of the peritoneum.

Treatment.—The treatment of infiltration must be prompt and energetic. As soon as symptoms indicating rupture of the urethra occur perineal section and divison of the stricture should be at once performed. Vesical drainage should be instituted by the insertion of a large rubber tube into the bladder. Thorough antisepsis by irrigations with very weak solutions of bichloride of mercury should be at once established. If diffuse swelling of the tissues of the perineum, scrotum, penis, thighs, or groins exists, a free incision should be made at each prominent point.

Whenever lancinating and throbbing pain with more or less circumscribed swelling occurs in the perineum, whether the scrotum be involved or not, perineal section should be made. An examination per rectum will sometimes detect extravasated fluid in cases in which the symptoms are otherwise very obscure. Under such circumstances the perineal operation should be performed, and a deep incision made in the direction of the perirectal infiltration. In making this incision the left index finger should be passed well up into the rectum to protect the gut from injury.

The only hope of saving life in cases of extensive extravasation consists in free incisions at all points where the infiltrated fluid can be reached. Even if the extravasation and subsequent cellulitis and sloughing be severe, a favorable result may often be secured by these radical measures. It is not sufficient to liberate the fluid that has already escaped, but it is necessary by section of the stricture and perineal drainage to prevent further extravasation.

Having obtained an outlet for the morbid urine, sloughs, and inflammatory material incidental to extravasation, some antiseptic dressing should be applied that will not only tend to maintain the parts in an aseptic condition, but will preserve the vitality of the cellular tissue. Both indications may be fulfilled by the application of hot poultices composed of equal parts of charcoal and linseed meal, sprinkled liberally with brewer's yeast or hot sublimate solution. All sloughs should be detached as soon as they become loose, and the parts irrigated daily to remove discharge as fast as formed. As the sloughs separate free purulent discharge occurs, constituting a severe drain upon the already depressed system. Liberal support, both dietetic and medicinal, will be required. Milk punch, egg-nog, large quantities of milk, and concentrated broths should constitute the diet. A liberal quantity of stimulants, either brandy, whiskey, or the heavier wines, should be administered. Should the patient's stomach be irritable, champagne is required. Digitalis, carbonate of ammonia, quinine, and tincture of the chloride of iron constitute the only reliable remedies against asthenia in these cases, and should be given in liberal doses.

Rupture of the bladder incidental to stricture demands the same treatment as under other circumstances, but is inevitably fatal.

Periurethral abscess is intimately associated with extravasation. The latter may be of comparatively trifling importance *per se*, the collection of pus being relatively of much more serious moment. Abscess about the urethra may arise from several causes. (1) The escape of a drop or two of toxic urine into the cellular tissue as a consequence of solution of continuity of the urethral walls. (2) From the escape of a drop or two of urine into a dilated follicle, with subsequent free suppuration and rupture of the latter. (3) Inflammation of the follicles due to the passage of instruments. (4) Puncture or rupture of the urethral walls by the beak of an instrument. (5) Phlegmonous inflammation due to the absorption of organic poison by the lymphatics from behind the stricture: this poisonous material, coming in contact with the cellular tissue, sets up suppurative inflammation.

Periurethral abscess bears a distinct relation to periurethral phlegmon and folliculitis. When decomposing urine escapes into the periurethral areolar tissue, it sets up inflammation which induces a plastic exudate; in some instances the exuded material closes the orifice through which the urine escapes and prevents further extravasation, thus circumscribing the abscess. Abscess of this kind may occur at any portion of the urethra, but is generally seen in the perineal part of the canal on account of its frequent association with stricture at the bulbo-membranous junction. It may subsequently lead to extravasation, because of its opening into the urethra, thus permitting the escape of the urine into its cavity, the walls of which subsequently yield, or it may burrow to the surface and heal externally without difficulty. Again, it may open internally and burrow externally without extensive extravasation, the track of the pus being limited by plastic deposit. Under these circumstances a fistula results. These abscesses are rarely dangerous *per se*, their importance being chiefly due to the danger of general extravasation and the formation of urinary fistulæ.

The amount of mischief done by urinary abscess will depend greatly on the particular side of the urethra that is involved. When, as usually happens, it forms at the lower surface of the canal, it readily comes forward without extensive burrowing; but when situated on the upper wall of the urethra (this is very rare) or at the upper part of the side of the canal, it may burrow widely before it points, occasioning great induration, infiltration, and destruction in neighboring parts.

The symptoms of periurethral abscess consist of the appearance of a small, circumscribed, tender, painful, and hard tumor somewhere in the course of the urethra. There is usually little or no constitutional reaction. Sometimes, however, in extensive abscesses more or less fever is noticeable. When located in the perineum this part may become tense, hard, and brawny, considerable weight and lancinating pain being complained of. Abscesses of this character are very slow in coming to the surface because of the comparative density of Buck's fascia which binds them down. If the pus escapes from its environment of plastic exudate, it is most apt to follow the course taken by infiltrating urine, there being less resistance to burrowing within the limits of Buck's fascia than to its escape externally.

Treatment.—The treatment of periurethral and perineal abscess consists of free incision with antiseptic precautions. It is bad practice to wait for fluctuation. When the penile portion of the canal is affected nothing is warrantable but a small puncture to relieve the distention of the abscess and prevent rupture into the urethra. Even in these cases, however, if puncture demonstrates the presence of pus, the abscess-cavity should be laid freely open. In perineal abscess a free incision should be made into the induration in the median line. Delay in these cases may lead to extravasation of urine. The after-treatment should consist of the ordinary surgical measures for the treatment of abscess.

Urethral Fistulæ.—Urethral fistulæ result from extravasation of urine and abscess. They are usually located in the perineum and scrotum, but have been noted in the groin, the inner aspect of the thigh, and upon the anterior abdominal wall as a consequence of extensive burrowing of pus. Their point of departure is generally in the vicinity of the bulbo-membranous junction; exceptionally they are met with in the scrotum and about the pendulous urethra. When they occur in the perineum they are often multiple, several openings being found about the perineum, nates, scrotum, and perhaps the inner aspect of the thighs. In a case reported by Civiale over fifty external openings were found to communicate with the perineal portion of the urethra. There is something remarkable in the manner in which the pus will creep about and form secondary fistulæ in these cases.

The number, location, size, and length of fistulæ are cardinal points in deciding their importance. Small perineal fistulæ with a single or perhaps two openings are not of very great importance, as they will close spontaneously in most cases as soon as all obstructions in the urethra have been removed.

The size of fistulæ depends entirely upon whether or not a loss of substance has occurred and upon the extent of the destruction. They may be large enough to admit several fingers. They are generally tortuous, narrow, and extend for a considerable distance; the external orifice may be very small, and may heal from time to time only to reopen, as in the case just related. Under such circumstances the urine remains in the course of the fistula, decomposes, and again produces suppuration with external discharge. In some instances burrowing occurs, resulting in tributary fistulæ running in various directions. In cases of multiple fistulæ the tissues of the scrotum, penis, and perineum become extremely hard and thickened, feeling to the fingers almost like cartilage. Where the stricture is tight and the fistula large the urine may not pass through the normal channel at all, escaping entirely *viâ* the fistula. Rarely indeed does the stricture become agglutinated, although such an accident may possibly occur in cases of traumatic stricture.

Treatment.—The treatment of fistulæ depends upon their location, number, and the question of loss of substance. The first principle in their management consists in the removal of all obstructions to the outflow of urine. A contracted meatus and penile stricture require incision as under ordinary circumstances. Care should be taken to restore completely the caliber of the urethra, for the more perfectly this is done the less resistance there is to the outflow of urine. By this procedure we take advantage of the physical principle that fluid tends to flow in the direction of least resistance. Should there be at any point in the course of the canal sufficient obstruction to produce distention of the urethra behind it, the backward and outward pressure will necessarily force a portion of the urine into the internal orifice of the fistula and thus prevent healing. The majority of simple perineal fistulæ will be found to close spontaneously as soon as the normal caliber of the urethra has been restored. The tissues in this situation are thick, and reparative action is consequently much more active than is the case in the penile portion of the canal. Then, too, the parts are not disturbed by erections, which, by depriving the affected tissues of rest, necessarily interfere with granulation and retard the process of healing.

Should simple fistulæ show a disposition to become chronic in any portion of the canal, the patient should be instructed in the use of the catheter and directed to draw his urine at regular intervals, thus obviating the possibility of the passage of the fluid through the fistulæ. Should such measures, however, tend to set up irritation of the urethra and bladder, it will necessary to discontinue them.

The process of repair may often be stimulated by cauterization of the track of the fistula. A good plan is to enlarge the external orifice of the fistula and pare its edges; its track may then be cauterized by passing a fine platinum wire attached to a galvano-cautery apparatus. This is passed into the fistula when cool, and then heated to a white heat and rapidly withdrawn. A fine probe, coated with a bead of sulphate of copper or nitrate of silver, may be used for cauterization. After the operation a soft, moderate-sized catheter should be left in the bladder to prevent any escape of urine through the fistula: it should be allowed to remain in the bladder for several days. The viscus should be irrigated with a warm, mild antiseptic solution at least once daily. Applications of the tincture of iodine upon a cotton-wrapped probe are sometimes effectual in promoting healing.

If the stricture be hard, resilient, or irritable, the best plan is to perform perineal section. All branching fistulæ that can be reached had best be laid open and left to granulate. After perineal section in stricture complicated by fistulæ the Harrison method of drainage should be adopted. This not only drains the bladder, but prevents the urine—which is invariably irritating—from coming in contact with the fistulæ. Fistulæ located in the scrotum often require free incision after the removal of urethral obstruction. Such fistulæ will often be found to be connected with unhealthy, sloughy abscess-cavities. These should be laid freely open.

Siphon-drainage has been recommended for simple fistulæ in the perineum. This method consists of tying a moderate-sized soft catheter in the bladder, which is attached to a rubber tube of considerable length passing into a receptacle containing carbolized water. Four cases cured in this manner are reported by Chiene.

Urinary fistulæ occasionally open into the rectum, in which event we have superadded to the obstacle to healing afforded by the contact of the urine an additional element—viz. the escape of fecal matter and gases. These latter materials are likely to pass not only into the fistula, but entirely through it into the urethra. Fistulæ of this sort are not apt to heal even after the urethra has been restored to its normal caliber. The ordinary operation for rectal fistula should be performed in such cases, the rectum and the greater portion of the track of the urinary fistula being laid into one cavity and made to granulate from the bottom. The rectal extremity of the fistula having healed, there may still be an opening in the perineum, the urine alone being sufficient to keep the urethral extremity of the fistula from healing. The perineal fistula may now be treated as under ordinary circumstances.

Thompson records an instance of successful treatment of recto-urethral fistula by position, the patient being instructed to pass urine only in the prone position.

Large fistulæ due to greater or less destruction of the tissues by which they are surrounded require, as a rule, special measures of operative treatment. The same may be said of fistulæ that fail to heal under the measures of treatment already outlined. Fistulæ in the penile portion of the canal, whether there be any loss of substance or not, are apt to be intractable to treatment. This intractability is due to the extreme tenuity of the tissues, which is unfavorable to plastic exudate and repair, and to the variable position of the organ incidental to erection and the performance of the sexual function, which prevents the necessary rest. Even with considerable loss of substance in the perineum fistulæ in this region will often close spontaneously, granulation and repair being very active and the parts being relatively infrequently disturbed. Loss of substance may occur in cases of fistulæ due to gangrene and sloughing, extensive abscess, phagedena, or the prolonged contact of instruments with the canal. Necessarily they are most often noted in severe cases of stricture.

Urethroplasty is usually necessary in large fistulæ of the penile urethra. Astley Cooper, however, reported a case in which the application of nitric acid was successful in closing a fistula as large as a good-sized pea after two successive plastic operations had failed.

Perineal fistulæ may often be closed by a comparatively simple operation. The edges should be liberally pared and brought together with the quilted or shotted suture. The author has succeeded in curing several of them by repeated suturing after preliminary cauterization.

Scrotal fistulæ require free paring of their edges. The tissues about the fistula should be extensively dissected up to secure thick, good-sized flaps of skin and areolar tissue. These should be stitched together by silver wire or by the quilted or shotted suture. Several operations may be necessary before the cure is complete, each operation making the fistula smaller. The urine must be drawn in all instances by the catheter. If the urethra be tolerant of the instrument, a moderate-sized soft catheter may be left in the bladder for several days. Irrigation of the bladder is necessary to maintain it as far as possible in an aseptic condition, so that in case urine comes in contact with the wound it may not prevent healing.

As a substitute for plastic operations Dieffenbach proposed a much simpler operation. A concentrated tincture of cantharides is applied to the edges of the opening and tract of the fistula. As soon as the epithelium has become detached and the surfaces are sufficiently raw a good-sized soft bougie is introduced into the canal; a needle armed with a strong, well-waxed silk thread is now introduced about a quarter of an inch from the edge of the fistulous opening. This is passed into the tissue of the corpus spongiosum for a short distance, and then made to emerge. It is re-introduced at the point of emergence, passed along, and brought out again in the same manner and at the same distance from the edge of the fistula. This procedure is repeated until the ligature completely encircles the fistula and terminates at the first point of introduction. The thread bears the same relation to the fistula that a draw-string does to the mouth of a bag. The two ends of the ligature being drawn together, the freshened surfaces of the fistula are closely approximated. A knot is now tied and allowed to sink into the point of puncture. The urine is to be drawn at regular intervals by means of a catheter. The ligature is allowed to remain for three or four days, then cut and withdrawn. Several operations may be necessary before the fistula is completely obliterated. The operation is only applicable to fistulæ of small size.

In the penile portion of the canal it is quite difficult to perform a successful operation of urethroplasty on account of the thinness and looseness of the integument and the sparsity of cellular tissue in this part. So scanty are the tissues that the surgeon naturally hesitates to pare the surfaces of the fistula sufficiently to obtain the desired result. Obviously, flaps with thick edges, such as can be secured in the perineum, heal much more readily than the thin ones which it is practicable to secure in the penile portion of the canal. Erections frequently occur and constitute another obstacle to success, as they produce tension and absolutely prevent the necessary rest.

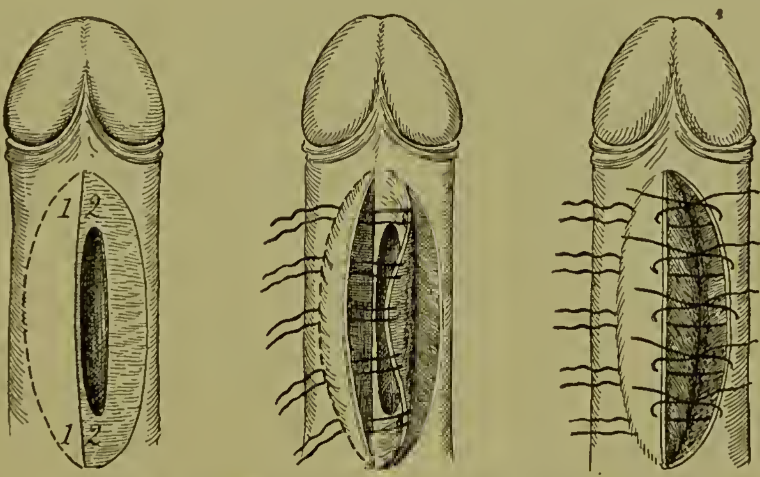

FIG. 59.—Szymanowski's operation for a large fistula.

Several special operations of urethroplasty have been devised. One of the best of these is that of Szymanowski (Fig. 59). This operation is performed in the following manner: When the fistula lies in the long axis of the penis, a straight incision is first made, beginning just in front of the fistula and terminating a short distance behind it. The integument upon one side (1, 1) is then dissected up so as to be freely movable. A half-oval flap (2, 2) of skin on the other side of the fistula is then outlined and dissected up, excepting at the edge of the fistula, its epidermis being first removed. The dissected flap is then inverted and pushed under the skin which has been freed upon the opposite side, as into a pocket. It is then retained in position by sutures passed into and through the bottom of the pocket. The movable skin is then slid over it and also stitched. An elastic catheter is passed into the bladder and there retained.

Nélaton's operation has been somewhat popular. It is performed in the following manner: The edges of the fistula should first be freely pared; the surrounding skin for an area of about an inch in breadth and extending a little beyond the fistula anteriorly or posteriorly should then be dissected subcutaneously by a narrow-bladed knife introduced posterior to the fistula. The raw edges of the latter are then brought together by fine sutures.

Another method is proposed by the same surgeon. The edges of the fistula are first pared and the skin separated for about half an inch upon each side of the opening. Lateral incisions are then made at a distance of about half an inch from the pared edges of the fistula for the purpose of relieving tension. A slip of thin india-rubber tissue may then be passed underneath the flaps of skin in order to prevent contact of urine with the raw edges and consequent disturbance of adhesions. Should the fistulous opening close, the lateral incisions very promptly heal. In both of these operations the extensive separation of the skin causes abundant granulations to spring up, with the result of closing the fistula.

In cases of extensive fistulæ of the penile urethra perineal drainage may be established after a plastic operation has been performed.

Ricord recommended for cases in which perineal or scrotal fistulæ coexist with fistulæ in the pendulous urethra that a catheter be passed through the lower fistula for the purpose of draining the bladder during the treatment of the penile lesion. He also suggested puncturing the bladder. Erichsen recommends that this be done through the rectum, but perineal drainage is far better. The opening made in the perineum by this latter operation will almost invariably close spontaneously when it has performed its function.

An operation for extensive penile fistula was recommended by Le Gros Clark. This is performed as follows: The edges of the fistula having been thoroughly pared, a transverse cut about an inch in length is made through the integumentary coverings of the penis a little distance in front of the fistula. Two transverse incisions are then made at the peno-scrotal angle, each being about an inch and a half in length. These transverse incisions are connected at each end of the fistula by a short longitudinal incision. The flaps of skin thus outlined are dissected up and brought together by means of clamps or the quilled suture. By this procedure two broad raw surfaces are brought together instead of a narrow raw edge of skin, and there is therefore a much better prospect of successful union.

DISEASES OF THE TESTICLE AND ITS COVERINGS, THE CORD, AND THE SEMINAL VESICLE.

BY EUGENE FULLER, M. D.

THE SCROTUM.

In considering the diseases especially relating to this part such cutaneous affections as more properly belong to the dermatologist will be omitted, while at the same time mention will be made of numerous conditions not properly classified as diseases of the scrotum, which, however, present peculiar and characteristic features in relation to this organ.

Edema.—The scrotum, being so elastic and distensible, is especially liable to be invaded by general dropsical effusions, under which conditions it becomes pale, cold, glistening, and tense. On being elevated and subjected to pressure, as by being squeezed between the palms, it will be found an easy matter to press out much of this effusion if it be recent, leaving behind shrunken normal scrotal tissue. Where, however, scrotal edema has been continuous for a long period and extensive, then inflammatory changes occur in the scrotal tissues. These structures become hard and brawny, and surface-blebs form on the dependent portions, followed by epithelial desquamations and by ulcerations, and occasionally by gangrene. The organ also in such an excoriated condition is exposed to germ-infection of various kinds, which may be followed by abscess-formation and sloughing.

In scrotal edema treatment should be directed toward the source of the effusion. Local measures should be conservative, and should consist in supporting and elevating the parts and in applying gentle pressure as with a flannel bandage. If excoriations occur, very mild antiseptic washes, followed by dustings with drying powders, such as powdered starch or talcum, are advisable. Punctures with needle or trocar and scarification are not usually to be recommended, since the benefit from them is temporary, and since such measures are apt to encourage ulceration and local gangrene.

Abscesses are not infrequent, generally involving the lateral walls of the scrotum. These usually form in hot weather, due to surface-infection at the seat of excoriation arising from chafing. After incision such abscesses heal without difficulty.

Urinary extravasation frequently invades the scrotal tissues, causing a tumefaction much as in simple edema. The urine, however, excites greater irritation than serous effusion ; consequently the scrotal tissues speedily become infiltrated by inflammatory exudates, causing them to feel hard and firm like pork. If such effusion is not speedily relieved, abscess-formation usually results. The treatment should consist of prompt and free incisions.

Emphysema sometimes occurs in this part, causing a swelling much like that of simple edema. Verneuil under the heading of pneumocele classes emphysema in this part under two divisions : (1) benign, where gas is introduced into the tissues through a local wound, or where its source is from some distant wound which communicates with the air-passages or bowels; and (2) malignant, where gas is generated in connection with bacterial fermentation. The benign form gets well spontaneously. For the malignant form incision, drainage, and thorough disinfection should be attempted.

Gangrene in this part may be associated with extreme and prolonged forms of edema occurring in the course of debilitating diseases in which dropsy is a feature; also, secondarily to urinary extravasation and after traumatisms. In such instances the gangrenous process is usually of limited extent and of minor importance. There is, however, a form of gangrene in this connection which occurs occasionally and which exhibits marked characteristics. This form is called "spontaneous gangrene." It appears suddenly and with little or no warning. The scrotum quickly swells, often to a great size. At first it is red. This color, however, rapidly becomes dusky, and soon the parts markedly involved become dark gray or black. After a day or so the line of demarcation forms, and then gradually the lifeless tissues slough off, leaving one or both testicles, according to the extent of the slough, exposed. Sometimes this destructive process is so extensive as to involve the penis as well as the scrotum. The exact cause for this form of gangrene is not known, though it is probably of bacterial origin. It occurs mostly in those addicted to alcoholic excesses, making its appearance directly after or during a prolonged debauch. Some of these cases are complicated by an emphysema. Surgical treatment in these conditions should always be most conservative. General supporting measures should be employed, together with careful attention to nutrition. The scrotum should be supported, dis-

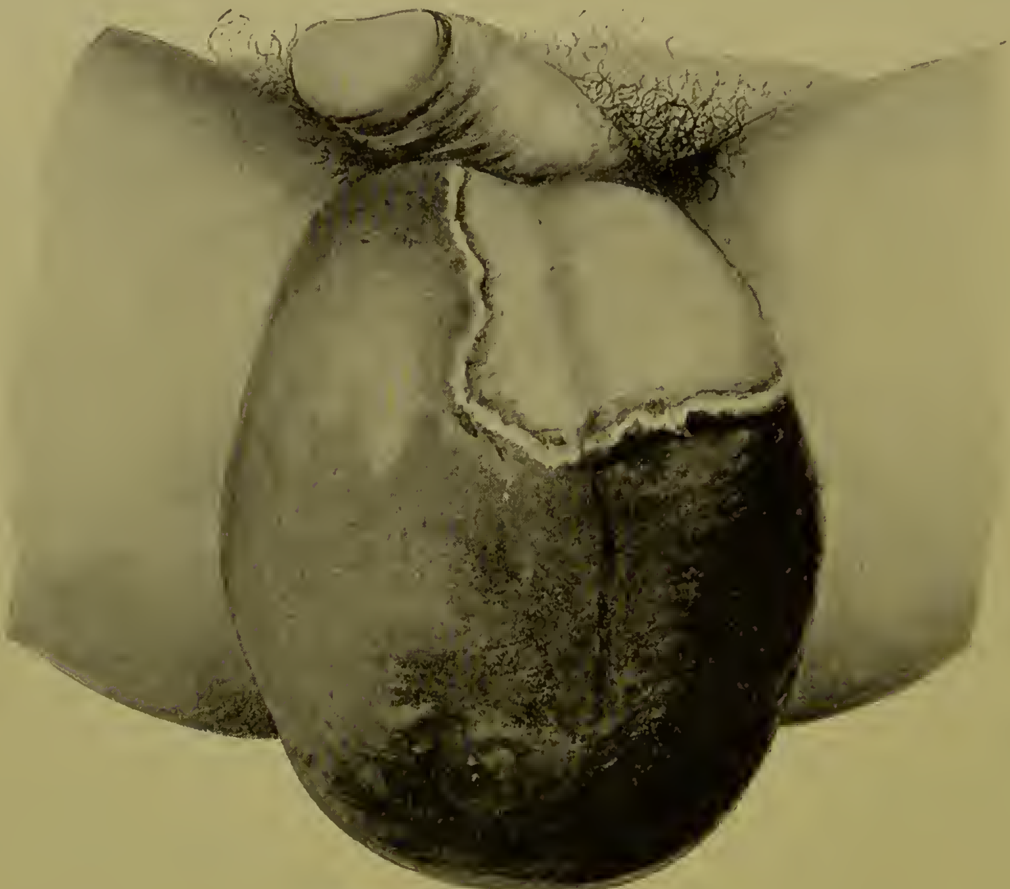

FIG. 60.—Gangrene of the scrotum (Allen).

infected, and enveloped in charcoal poultices. Necrosed masses should be removed as fast as they become detached. They should not, however, be cut away along the line of demarcation, lest live tissues be damaged, thus exposing the system to further septic absorption. After the slough has become entirely detached the remaining scrotal flaps should be left to granulate and to extend by cicatrization over the exposed testicles. It is wonderful to what an extent Nature, if left to herself, will accomplish repair in these cases. C. W. Allen of New York has lately published an interesting article on this subject.

Elephantiasis.—The scrotum is a favorite seat of this affection. When so attacked this organ may become of great size (Fig. 61). In fact, it has been known to reach the weight of 150 pounds. The disease is slow, painless, and progressive. It is almost wholly confined to hot countries. The Barbadoes, parts of India, Egypt, China, the East Indies, and Brazil furnish most of the cases. It also exists to a limited extent among negroes in our Southern States. The scrotal tissues, especially in long-standing cases of the disease, become very hard and fibrous. The surface of the organ is not smooth, as might be expected, but is rough, furrowed, and studded with tuberosities. The growth is due to interstitial hypertrophy. Lymph-scrotum is a term applied to an enlarged tumefied condition of the scrotum caused by a blocking of its efferent lymph-ducts. Such a blocking is caused by the presence in the efferent lymphatics of the male and female worms, the larvæ of which are the filiaria sanguinis hominis. In this condition the scrotum is not hard, but boggy to the feel. Its surface is tense, but not smooth, however, as it is covered with little lymph-vesicles. Such a scrotum on being removed collapses, if the disease is not of long standing, as the lymphatic engorgement drains off. If a lymph-scrotum is of long standing, then interstitial changes take place in connection with the connective tissues, causing a condition either of true elephantiasis or one which cannot be distinguished from true elephantiasis. There has been much discussion regarding the etiology of elephantiasis. Numerous authorities hold that no distinction should be made between the two conditions; in other words, that all cases of elephantiasis, just as is the case with lymph-scrotum, are due to parasites which block the efferent lymph-channels.

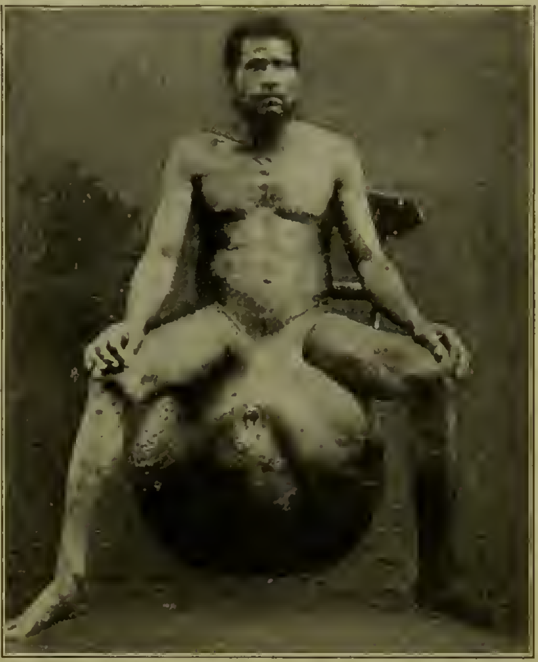

Fig. 61.—Elephantiasis of the scrotum in a native of Fiji (Thorington).

The medical treatment of these hypertrophies has hitherto been unsatisfactory and negative. Very recently Flint of New York has published some cases of filiaria sanguinis hominis which have apparently been cured by the internal administration of methylene-blue for a considerable period. If these results are substantiated by further investigations, it may be that we shall have a cure for elephantiasis or such forms of it as may be dependent on filaria. Generally quite satisfactory results can be obtained by surgery in these cases. The pedicle is clamped and the scrotal tissue removed, care being taken to leave the testicles and penis. The exposed testicles become covered by granulations and cicatrization. The chief danger with reference to the operation lies in septic absorption from the stump, but with careful attention to antisepsis death from this source should not be frequent. Formerly, before it was customary to apply a clamp to the pedicle, the danger due to hemorrhage was considerable, since the blood-vessels which have to be secured are numerous and large.

Tumors.—Dermoid cysts of the scrotum occur occasionally. Mermet has recently reported 2 instances of such tumors occupying the median scrotal raphé (Fig. 62). Sebaceous cysts are common. They frequently attain the size of a pea. Such growths may stud the whole scrotal surface. If one of these becomes inflamed, a localized abscess forms. Cystic, fatty, and fibrous tumors also occasionally occur. Cancer in this part is customarily epithelial, although scirrhous and medullary varieties have been noted. Epithelial cancer of the scrotum is confined almost exclusively to England, and in that country chimney-sweeps are the class of people affected. Butlin of London has recently considered this subject most thoroughly. He finds that chimney-sweeps of other countries, owing apparently to differences in dress, rarely have this form of disease. The disease begins as a soft moist wart, which gradually spreads over the entire scrotum, associated with more or less induration and ulceration. Sarcoma is rarely found here. Occasionally such growths are melanotic. Benign growths are easily and successfully removed. Malignant ones should in all cases be attacked by the knife, unless the neighboring structures are too much involved, if the general condition of the patient is such as to warrant radical measures. It is best while doing a radical operation to remove the inguinal glands as well as one or both testicles, should these organs be at all adherent to the scrotal structures.

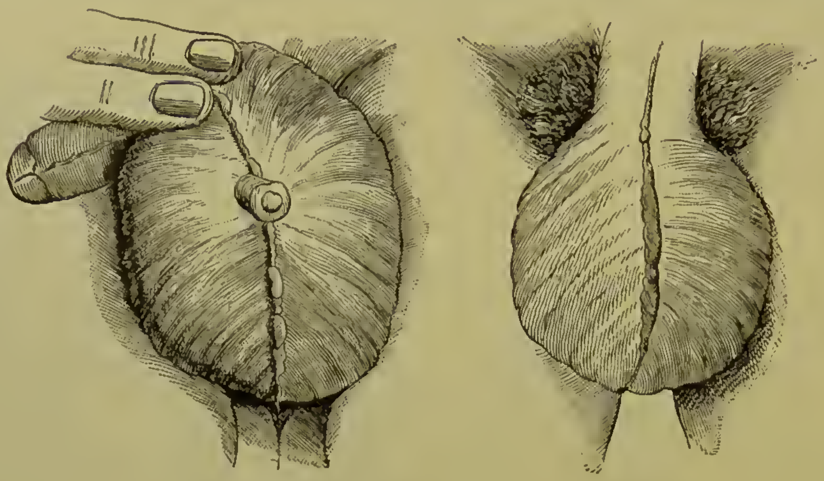
FIG. 62.—Dermoid tumors of the scrotal raphé.

Redundancy of the scrotum is every now and then a cause of complaint. Such an apparent condition of affairs may be due to an interstitial hyperplasia following an eczema or a condition of long-continued irritation, such as may be caused by pruritus, by pediculi, or long-continued tension. A relaxed condition, however, of the dartos accounts for most such instances. Varicocele generally accompanies this latter condition. When such is the case a cure of the varicocele will usually be followed by a cure of the redundancy. If, therefore, the varicocele is eliminated, it is not necessary, except in a very few extreme instances, to remove any of the scrotum in order to accomplish a cure.

Varicose veins occasionally occur in the scrotum itself of sufficient size to occasion disagreeable dragging sensations. Varicocele usually complicates this condition. To cure such a case the veins should either be tied or the portion of the scrotum chiefly affected removed. The scrotum is rarely the seat of nevus.

Traumatisms in the form of lacerations and contusions are quite frequent. In a case of laceration little or no tissue should be removed at the time of the accident. The parts should be cleansed and dressed antiseptically. If a slough occurs, it should be removed only after nature has clearly shown its extent. When contused the parts should be supported and cooling lotions applied.

THE LOOSE CONNECTIVE TISSUE SURROUNDING THE SPERMATIC CORD.

This structure is rarely invaded by serum, blood, or pus. When invaded by serum a swelling is formed which has been called diffused hydrocele of the spermatic cord. Such a swelling is more or less pyramidal in shape, the base being downward. The base is determined by the firm fibrous tissue which just above the testicle forms a septum, below which the effusion cannot extend. The lateral walls of the cone are made up of the firm fibrous sheath investing the cremaster muscle. The apex of such a tumor extends upward with the cord, so this limit is somewhat indefinite. Pott refers to an extreme case of this nature in which the effusion extended upward along the cord clear to the abdominal cavity. When these serous tumors are recent their interior contains a network of loose fibrous tissue. This network, however, in time gradually gives way, so that it does not appear at all or only partially if the effusion is of long standing. Hemorrhage into this loose fibrous tissue, such as occasionally occurs as the result of a traumatism or of some special muscular effort, will cause a tumor to occur of similar dimensions and position as the serous one just described. Such a collection of blood has been called diffused hematocele of the spermatic cord.

Suppuration in this connection, although rare, is of importance, owing to the difficulty which often attends its diagnosis. When a suppurating tumor exists, its limits are not as sharply defined, especially if it is of some duration, as is the case with the other fluid tumors just described. The upper portion of the tumor, instead of being conical and limited, is apt to be sausage-shaped, boggy to the feel, and without defined upward limits. In many instances the external inguinal ring cannot be made out, owing to the mass of induration which surrounds it. The scrotal tissues also external to the fascia beneath the cremaster muscle frequently become secondarily involved to such an extent that they present a thickened, edematous appearance.

A serous tumor in this part can be distinguished from a vaginal hydrocele, since the testicle can be felt loose and movable below it. Its shape and generally ill-defined outlines will serve to distinguish it from an encysted hydrocele of the cord, from an encysted hydrocele of the testicle, or from a spermatocele. A tumor of this nature is especially apt to be mistaken for an inguinal hernia. Like an inguinal hernia, it can in many instances be more or less compressed while the patient is recumbent, reappearing again shortly after he stands up. In some such cases it is probable that the fluid from the tumor can be pressed up along the cord to the abdominal cavity. It differs from an inguinal hernia, however, in the following particulars: It does not, as a rule, obscure the feel of the external inguinal ring, that structure appearing normal; there is no impulse to be felt by the finger at the external ring when the patient coughs. On reducing an inguinal hernia by digital compression, especially when the patient is lying down, the tumor when it disappears does so suddenly, and with the characteristic feel of slipping away suddenly. With a serous tumor, however, digital pressure will only at best cause a partial disappearance of the tumor, and such a disappearance will be very slow, never sudden and never associated with a slipping sensation. The serous tumor may be transparent, but not always so, owing to the thickness of its walls. The percussion note is always flat. With inguinal hernia, however, containing a knuckle of gut the note is resonant. A partially descended testicle associated with hydrocele, as also a hydrocele of an old hernial sac, might be mistaken for a serous effusion into the loose tissue about the cord; but, as these conditions are very rare, a consideration of the differential distinguishing points will not be here attempted. Much that has been said regarding the differential diagnoses with respect to a serous tumor in this part applies also to a hemorrhagic one. A hemorrhagic one, however, differs from a serous one in that it always appears suddenly after a traumatism or great exertion. It is not in the least transparent. It may be quite tender, especially when recent.

Between a suppurating tumor of this part and suppuration generally in connection with a hernial sac it is often impossible to differentiate, the exact diagnosis being determined only after a free incision has been made.

The **treatment** for these different fluid tumors is free incision, antiseptic irrigation, and thorough drainage. Great attention also should be paid by careful dressings to maintain strict antisepsis after the operation, since in these loose structures infection if once introduced may extend rapidly. Before the days of antiseptics such operations were attended with some risk, but with our present methods bad results should be very rare. Occasionally serous collections will not reappear after puncture with a trocar or aspirator, so these mild means had better be tried in such instances before a radical measure is attempted. To inject them, however, after aspiration, as is done in the case of vaginal hydrocele, is not advisable, since they have no serous lining, and consequently the inflammation so set up might extend upward along the cord and into the abdomen.

Varicocele.—This consists of a varicose condition of the veins accompanying the cord and lying in the loose fibrous tissue surrounding it. These veins convey blood from each testicle and epididymis. Varicocele is far more commonly met with on the left side than on the right. This occurrence has been accounted for partly by the fact that the spermatic vein on the left side, by reason of its passing beneath the sigmoid flexure, is more or less compressed, especially in constipated subjects, and also because on the left side the spermatic vein enters the inferior vena cava indirectly through the left renal vein, whereas on the right side the entrance of the spermatic vein is directly into the inferior vena cava. Both of these conditions by tending to impede the blood-current would tend to make the fluid-pressure in the veins on the left side greater than on the right. If one examines these long spermatic veins and follows their course through the narrow inguinal canal, where under so many conditions of exercise their calibers must be compressed, the fact that their dependent branches become frequently varicose can be easily understood, especially when it is seen that the branches which become enlarged lie in a loose fibrous meshwork which of itself gives no external support to the venous walls. These intra-scrotal veins, especially on the left side, are probably slightly enlarged in the majority of young adults. Such slight enlargements should not, however, be noted as of pathological importance. It is only when these veins are so enlarged as to become visible to the eye and feel and to cause some scrotal relaxation that the term varicocele should be applied to them. Varicocele generally makes its appearance in young adults of sixteen to twenty-five years of age. From the time of its appearance up to middle adult life it may be the cause of much inconvenience. In later life it rarely gives trouble. In fact, in many instances it spontaneously disappears after middle life. It is thus seen that its limit of greatest development corresponds closely to that of the greatest sexual development. Sometimes it appears in young boys of ten or eleven. In most cases of varicocele no special causes aside from the general ones just enumerated seem to exist to account for the complaint. In numerous instances, however, varicocele has first become noticeable and troublesome after violent exercise, long-continued sexual excitement without relief, and sexual excesses or abuses, so that it is reasonable to suppose that such agencies may be classed as contributory causes.

Varicocele, after being once seen and carefully considered, can generally be readily recognized in the future. The testicle on the side affected hangs lower than normal and the scrotal covering is relaxed, thin, and atonic. Occasionally both sides are affected, in which case corresponding appearances exist on both sides. On inspection a convoluted tumor appears, generally especially prominent in the middle lateral portion of the scrotum, though in some extreme instances the whole lateral sac may seem to be distended by it. To the feel it appears soft, slippery, and compressible. It has been likened in appearance and to the feel to a bundle of earth-worms done up loosely in a bag. If the patient so affected lies down on his back, the tumor immediately and entirely vanishes. On this account it is like an inguinal hernia, but in all other respects it is very different, for with varicocele, if one examines the external inguinal ring it will be found to be normal and on coughing there is no impulse. When a patient affected with inguinal hernia lies down, the finger applied to the external inguinal ring will prevent the resulting scrotal tumor from reappearing when the erect posture is resumed. The same maneuvers in the case of varicocele will not only not prevent the scrotal tumor from reappearing, but will cause it to reappear of greater size than normal, since the finger so applied will serve to dam up the flow of venous blood and thus to over-distend the already diseased veins. In all cases where a varicocele is at all extensive an examination of the corresponding testicle will show that organ to be soft and undersized, owing to the fact that its blood-supply is diminished. This diminution in blood-supply is caused not only by the fact that the outflow of blood from the testicle is impeded by the distended and diseased condition of the efferent veins, but also by the pressure which the venous tumor exerts on the gland. It is probable that the soft and wasted testicles encountered in severe grades of varicocele have lost their function.

The subjective symptoms dependent on this condition consist chiefly of dragging sensations in connection with the scrotum. These sensations are often associated with pain, which may be dull and localized or sharp. When it is sharp it often radiates upward along the spermatic cord, and from there sometimes on toward the kidney or back toward the sacrum. These painful sensations are especially noticeable after exercise, such as horseback, tennis, etc., after and during prolonged sexual excitement, and as the result of standing about or walking for a long interval. Consequently the existence of varicocele is considered a sufficient disability to act as a bar to those seeking such positions as policemen, cavalrymen, and the like. It is commonly supposed, and to a considerable extent true, that the presence of varicocele occasions sexual weakness. As has been seen, an extensive varicocele causes more or less atrophy of the testicle in connection with it, and it is often to be noted that after a cure of a varicocele the hitherto partially withered testicle becomes firm and equal in size to its mate, while at the same time the sexual vigor increases and regains its old-time force. Still, it is very unsafe for a surgeon without studying the case to argue to a patient suffering from varicocele and also sexual weakness that a cure of his varicocele will lead directly to a cure of his sexual weakness, since sexual weakness is far oftener due to other causes, chief among which is seminal vesiculitis, than to varicocele, and should any one attempt, as is often done, to cure a case of sexual weakness due, for instance, to seminal vesiculitis, by operating on an existing varicocele, not only will the sexual weakness remain unimproved, but it will in many instances be intensified. Therefore the surgeon, although he may have cured the varicocele, will yet be brought into discredit, since he has reasoned on a false hypothesis. The only way in such instances, and in fact in all instances, is for the surgeon to investigate his case carefully before giving his prognosis. The treatment of varicocele may be palliative or radical. Palliative measures consist of local support, such as may be rendered by a well-fitting suspensory bandage, cold douches alternated at times with hot ones, external applications, and the avoidance of the causes such as we have seen to be conducive to the development of the disease. Internal medication does no good. The treatment by means of a suspensory bandage is generally unsatisfactory, since if one once begins to wear such a support to relieve symptoms due to varicocele, it generally has to be worn indefinitely. Cold douches, especially such as are found in hydropathic establishments, which throw a strong stream vertically upward, often do much temporary and sometimes continuous good by stimulating the muscular tone of the parts. In some instances stimulating lotions will be found to do some good, probably by exercising a like stimulating effect. The only satisfactory methods of treatment, however, are the radical ones, by which the diseased veins are obliterated or removed by surgical procedures. With reference to the choice of procedures to be adopted to accomplish such results there is still considerable discussion. These methods can be classed as subcutaneous and open. Then there is another surgical method, which aims by ablation of a portion of the scrotum, in cases where that part is much relaxed, to support the testicle and its varicocele by the formation, as it were, of a natural suspensory.

The subcutaneous method deserves, in the writer's opinion, first mention, as being the most satisfactory procedure. It is the least dangerous; it entails the least confinement in bed, five days to a week being all the time required; and the after-results are satisfactory in cases where the operation is properly performed. Against this method it can be said that it requires more skill and assurance in its performance than the other operations. This is because the patient during all or most of the operation is not under the influence of an anesthetic. No anesthetic can be given, at least during the early steps in the operation, since it is necessary that the patient should remain standing while the ligatures are put in place; otherwise, if in the supine position, the veins to be ligated become collapsed and consequently indistinguishable. The surgeon, therefore, doing the operation under the eye of the patient feels that any tardiness or clumsiness on his part in placing the ligatures will be or may be noticed, and if he does not know the steps of the operation well, he is liable on this account to become bewildered and to place his ligatures badly, and consequently to make a fizzle of what ought to have resulted to his credit. Many, after failures of this description, unjustly blame the subcutaneous operation, just as poor workmen blame their tools. Keyes of New York has done much to develop this operation and to make it a success by employing heavy Chinese silk for ligatures in the place of catgut, which he formerly used, which was productive of unsatisfactory results, since it became absorbed and loosened before the obliteration of the diseased veins had been accomplished. Other arguments advanced against the operation are that the cord may be tied in by mistake, and that many tissues and nerves are harmfully included in the ligation, causing subsequent atrophy of the testicle. If the cord is tied in, it is the fault of the operator and not of the operation. Atrophy of the testicle does rarely occur after this operation, and this fact should always be mentioned to the patient before doing the subcutaneous operation for varicocele, or, in fact, the open operation, as occasionally atrophy follows that also. Just why atrophy of the testicle occasionally occurs is not definitely determined, but it is probably due to injury to the nerves supplying the part. In the vast majority of instances the nutrition of the testicle in connection with a varicocele is aided by the operation, owing to the improvement which follows in the circulation of the blood through the organ. Consequently the testicle after a time is apt to increase in size and become firm to the feel. As the steps in Keyes' operation are now so well known to the profession, a detailed recital of them will not be here attempted. It suffices to say that the patient stands nude, with the exception of a short shirt, on a rubber cloth supported by the arm of an attendant. The scrotum and genitals after being shaved are carefully disinfected. The bunches of veins are separated from the cord. Then two straight previously-threaded Reverdin needles are plunged through the scrotal tissues in the space between the cord and the veins, the position of the upper needle corresponding with the top of the varicocele, while the lower one is just above the level of the epididymis (Fig. 63). Sometimes in severe varicoceles a third needle is needed to tie a cluster of veins below the epididymis, but a description of this ligature will not be given, since its technique is similar to that of the others. In placing each ligature the following manipulation is necessary: The point of the needle piercing the back wall of the scrotum brings with it a loop of the ligature. With a little tenaculum the loop is seized, and one end of the ligature is pulled through and the needle unthreaded. Then the needle is so withdrawn that its point is just within the dartos at the anterior scrotal puncture. Next the point of the needle is gradually worked around the bunch of veins until it arrives at the posterior dartol puncture, extending through which has been left the farther end of the silk ligature. The point of the needle is then again brought out through its original posterior scrotal puncture alongside of the ligature. A loose loop of the posterior end of the ligature is then re-threaded into the eye of the needle and the needle withdrawn, its point leaving the scrotum at the original anterior puncture. It will thus be

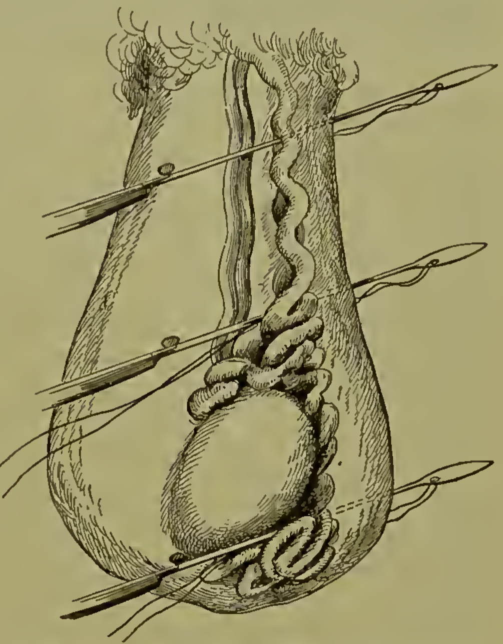
FIG. 63.—Diagram showing operation for varicocele (Keyes).

seen that the ligature is left placed about the veins. Each ligature is thus placed. No tying is done until all the ligatures are in position. The patient is now allowed to lie down. If he is fearful of pain, a whiff of chloroform can at this time be given, so that he will not feel the tying of the ligatures, the only really painful step in the operation. The ligatures should be tied very firmly, three square knots being employed. Then the dartos round about all the ligatures should be forcibly pulled away, allowing them to retract widely from the surface of the scrotum. The scrotum should be covered with antiseptic gauze, packed in wool or cotton, and left well supported by a suspensory bandage. There is no blood, no oozing, and little after-treatment required besides rest in bed for five days to a week. A firm mass remains at the site of the varicocele, which is gradually absorbed. Occasionally a silk ligature does not become encysted, but gradually works its way to the surface.

The open method of operation consists in making a longitudinal incision through the scrotum of sufficient length to enable the operator to expose the diseased veins. When this has been done one firm ligature is placed about the vessels above the varicocele and another about those at the bottom of it. The intermediate venous mass is then excised. The results from such a procedure are good, but no better than those in connection with the subcutaneous method. The danger is far greater, since infection has to be carefully guarded against, and convalescence is much slower, two or three weeks in bed being required.

Ablation of the scrotum in order to form a natural suspensory is a procedure generally attended with but moderate success. Oftentimes this operation is combined with the one just described under the open method. When once the varicocele is destroyed the scrotum almost always so contracts as no longer to appear redundant. Therefore ablation of the scrotum in connection with excision of the veins is rarely necessary.

Hydrocele.—When this term is used without an adjective to define its variety the ordinary form of hydrocele is always implied. This form, which is more particularly described as vaginal hydrocele, consists of a collection of fluid, more or less serous, in the cavity of the tunica vaginalis. The scrotal tumor resulting from such a collection generally assumes an egg-shaped contour in connection with the side of the scrotum involved, its larger end being the dependent one. A small hydrocele may appear as large as a billiard ball, a large one the size of an ostrich egg; while rarely the collection of fluid may make a tumor sufficiently large to extend downward nearly to the knee. The scrotal outline of the tumor is generally quite smooth. It is not tender to the feel when of the ordinary chronic variety. On holding it in one hand and tapping it sharply with a finger of the other, a wave of transmission can generally be detected, the percussion note being flat. The walls of the tumor are generally tense except in old hydroceles which have been tapped, in which instance, the old sac having but partially refilled, the walls may be flabby. An important feature in connection with a hydrocele, especially of this description, is its transparent quality. This transparency can be demonstrated, except in rare instances of old hydroceles with very thick walls, by darkening the room and then placing the tumor, its scrotal coverings being made tense, in the line of vision between the eye and a bright light. Oftentimes by so doing a dark spot can be detected marking the position of the testicle, which lies in the tumor largely surrounded by fluid. The fact that in vaginal hydrocele the testicle is within the fluid tumor, and consequently cannot be felt outside of it, is a point of much diagnostic importance. Aspiration will demonstrate the fluid contents of the tumor. If one bears in mind the characteristic features of vaginal hydrocele, there ought commonly to be little difficulty in making a differential diagnosis. Occasionally, however, an extensive hydrocele may simulate an inguinal hernia. Hematocele also resembles hydrocele in many respects. The points of difference, however, will be studied when this latter condition is considered. If hydrocele is not of considerable size, its upper rounded margin can be felt below the external abdominal ring, and consequently inguinal hernia can be immediately excluded. Sometimes, however, the upper border extends so far up that it seems to the feel to be continuous with the external ring, and it is such cases that resemble more or less closely inguinal hernia. The following are, however, the important points of difference: The history of hydrocele is that of a dependent tumor which has gradually extended upward; with hernia it is the reverse. The development of hydrocele has been slow, painless, and constant; with hernia it has generally been sudden, while at times the tumor would disappear suddenly, and then in like manner reappear, associated with more or less painful sensations. Hydrocele is transparent, hernia opaque; hydrocele on percussion is flat, hernia, especially if of large size, somewhat tympanitic, owing to its intestinal contents. With hydrocele no testicle can be felt; with hernia that organ appears distinctly outside of, and generally below, the tumor. Occasionally hydrocele and inguinal hernia coexist. Such a complication ought, however, to be correctly diagnosed, since the point of approximation of the two tumors can generally be felt and their differences in consistency detected.

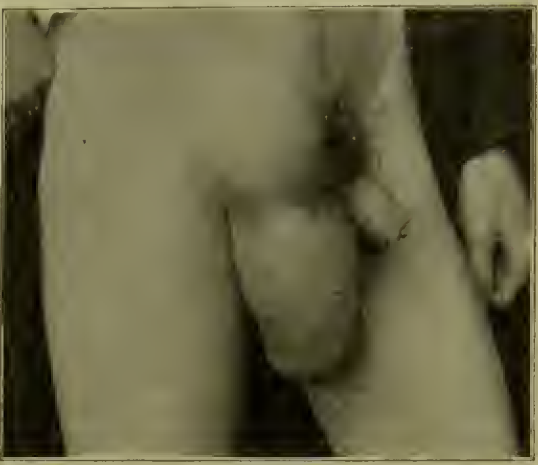

FIG. 64.—Hydrocele (Keen and White).

Another most important point in diagnosis is to determine whether a case of vaginal hydrocele is one of true hydrocele, or whether it is one where the hydrocele exists simply as a symptom of some underlying disease, as cancer, tubercle, or syphilis of the epididymis or testicle. In true vaginal hydrocele the disease lies apparently in the secreting epithelia lining the sac, other structures being normal. Consequently, the prognosis and treatment of simple hydrocele and of hydrocele symptomatic of disease of the epididymis or testicle are widely different The only way to settle this question in cases where the hydrocele is tense is to draw off by aspiration a portion of the fluid in order that the testicle and epididymis can be felt. If then the parts feel normal, a positive diagnosis of simple hydrocele can be given, with a good prognosis as regards the outcome of the disease as well as its cure.

The form of hydrocele under consideration is chronic. There is an acute variety of vaginal hydrocele, but as this is simply associated with and symptomatic of some correspondent inflammatory condition of the testicle or epididymis, it needs no further mention here. The etiology of vaginal hydrocele is not well understood. The cause for it seems to lie in the secreting serous epithelia. The disease generally begins insidiously, and especially affects men round about or after middle life. When it once begins, it generally persists until cured by surgical measures. When hydrocele is not of long standing its walls are thin and elastic. These eventually, however, become thick, sometimes to the extent of one-fourth of an inch, hard, and unyielding. This is caused by a fibrous proliferation in connection with the subserous connective tissue. Rarely the thickened walls become infiltrated with lime-salts. This thickening of the walls, besides making diagnosis more difficult, interferes somewhat with satisfactory resolution after operation.

The fluid drawn from hydrocele is usually of light specific gravity and pale straw color. Sometimes, however, it may be thick like syrup, or its color may be darkened somewhat by blood-pigment. When a fluid is so darkened, however, underlying disease of the epididymis or testicle may be suspected.

Treatment.—Hydroceles which are simply symptomatic of morbid conditions of the testicle and epididymis depend for their continuance on those conditions, and consequently need no special consideration as regards treatment. The remarks here apply only to true vaginal hydrocele. Internal remedies and external applications given in the hope of promoting absorption are useless. Very rarely hydrocele gets well spontaneously, but commonly the fluid has to be drawn off in order to reduce the tumor. To do this an aspirating needle or a trocar and cannula are necessary. The tumor after being disinfected should be taken in one hand, its scrotal covering put on the stretch, and the needle, held in the other hand, plunged in until its end is felt to be well within the fluid cavity. In selecting the spot for the needle to pierce care should be taken to avoid the testicle. This organ generally, though not always, lies behind. If the transparency of the spot to be pierced is first determined, the testicle can always be avoided. Care also should be had to avoid wounding scrotal vessels. The fluid generally is of such consistency as to run freely through the needle, leaving the sac collapsed. This process is called tapping. It is not a painful procedure, and it is almost devoid of risk if done in a cleanly manner. Rarely, however, if care is not exercised to avoid the testicle and epididymis, a blood-vessel may be wounded, followed by a hemorrhage into the sac, hematocele resulting. Such treatment, though it gives relief for weeks or months, is not radical, since the fluid reaccumulates in the sac and the procedure has to be repeated. Radical treatment consists in injecting the sac with some irritant immediately after it has been tapped, in making an incision into the sac followed by drainage, and in excising more or less of the parietal lining wall of the sac. This last method is called the Von Bergmann operation, and is especially intended for such old cases as have very thick and infiltrated walls. The injection method is suitable in most cases, and is the author's method of choice in the great majority of them, since its results are good and radical, while it subjects the patient to but little pain, to the least confinement, and to the least danger, although the question of danger is not a prominent one in connection with any properly performed operation for this disease. The material to be injected into the empty sac is 95 per cent. carbolic acid to the extent of from 30 to 60 minims. Other substances, especially compound tincture of iodine, have been used, but have not been found efficacious like the strong carbolic-acid solution, while at the same time they have been productive of much pain. The technique of this operation is as follows: The fine needle, detached from its syringe, which contains the carbolic-acid solution, should first be plunged well into the sac and left there. Then the larger-calibered aspirating needle (or better a trocar and cannula attached to an aspirator) is introduced and all the fluid drawn off. Next the syringe containing the carbolic solution is attached to the fine needle without withdrawing it from the sac, and the solution injected. The injection causes a peculiar pain for a moment or so, after which the patient generally experiences little discomfort. If the hydrocele is very large and tense, it is better as a preliminary measure to draw off most of the fluid, and then later, when it is smaller, to draw off the fluid again and inject it. When a failure to cure follows this operation, it is generally due to the fact that the hydrocele was not thoroughly emptied of its fluid prior to being injected. After the hydrocele has been successfully injected the sac partially refills very promptly, due to the inflammatory reaction caused by the carbolic acid. This inflammatory exudate, however, is gradually reabsorbed after the inflammatory process giving rise to it has subsided. No anesthetic is required in this operation. After the operation the scrotum should be supported for some time, but the patient need not be confined to bed. The operation by incision and drainage requires confinement in bed until such time as the sac has been obliterated by the formation of adhesions between its parietal and visceral walls. This commonly, however, does not take many days. In performing this operation the sac is opened in a dependent position under antiseptic precautions, and a rubber, catgut, horse-hair, or wick drainage inserted and kept in position until the necessary adhesions have been formed. Some advocate stuffing the sac loosely with iodoform gauze, and then gradually removing the packing as the adhesions form. The results from this operation are generally satisfactory. An anesthetic may or may not be required.

The operation by excision of a portion of the sac is perhaps the most radical of all, and at the same time the most extensive. It is only called for in a few very old hydroceles with very thick walls, and especially where the thickening of the walls is due to sclerous and calcareous changes in the subserous tissues. In such an operation the cavity formed by the sac has to be obliterated by granulation. Consequently thorough drainage must be maintained until the process of repair is complete.

Encysted Hydrocele of the Testicle.—Many times a hard, rounded tumor can be felt in connection with the epididymis or testicle, bulging out under the the visceral layer of the tunica vaginalis. Such a tumor is generally small, not larger than a pea or a grape, although it may rarely attain to the size of a goose-egg or even larger. In many instances such tumors are multiple, especially in connection with the epididymis. On aspiration they will be found to be cystic. The fluid drawn from them is generally transparent, though it may be more or less opalescent, due to suspended fatty degenerated particles. It may also be somewhat albuminous. These cysts, when occurring in or originating from the crease between the epididymis and testicle proper, consist of a localized serous effusion in the folds of the tunica vaginalis, which effusion is cut off from the general cavity of the tunica vaginalis by the natural adhesions which here occur between the folds of serous membrane. Cysts of this nature may be of considereble size. In most instances, however, they are subserous, and when originating from the epididymis they may oftentimes be identical with the hydatids of Morgagni. The name "encysted hydrocele of the testicle" has been applied to tumors of this description. Transparency cannot always be demonstrated in them.

Spermatocele.—The same general description applies to spermatocele as that just given in describing the gross appearance of encysted hydrocele of the testicle, except that spermatocele in size averages larger (it frequently being as large as a walnut or hen's egg), and its situation, especially when it is connected with the body proper of the testicle, may be and often is deeper seated than is the case with encysted hydrocele of this part. This difference in situation is easily understood when the difference in etiology between the two conditions is taken into account, spermatocele being a retention-cyst formed by an occlusion of a secreting duct. However, the clinical appearances of these two varieties of cysts are so similar that the only way to differentiate between them is by aspiration. Then if examination of the fluid shows spermatozoa to be present, the tumor is classed as a spermatocele: if these organisms are absent, it is called an encysted hydrocele of the testicle. This differential diagnosis may not always be pathologically correct. The fluid drawn from spermatocele is generally opalescent, and sometimes almost milky; consequently the tumor is not transparent.

These two conditions of the testicle and epididymis may be confounded with encysted hematocele, pyocele, or a solid growth of the part, and the aspirating needle may be called for to settle the question. The treatment for both these preceding conditions is the same. Simple tapping will usually prove of but temporary benefit, just as with ordinary vaginal hydrocele. For radical cure tapping followed by carbolic-acid injection is recommended. In these instances, however, since the sacs are usually small, a small quantity of 95 per cent. carbolic-acid solution, say from ten to twenty minims, will be sufficient for injection.

Encysted Hydrocele of the Cord.—Occasionally a cystic tumor lies in the loose tissue alongside the cord. Such a tumor is generally oblong, its long diameter corresponding with the direction of the cord. Its upper circumference can generally be easily made out below the external inguinal ring, although at times it may extend up to that part, and rarely even into it, in which cases it may simulate inguinal hernia. Its lower circumference also can be felt free and independent of the testicle, that organ lying below in all cases, except occasionally where the cyst is very large, in which instances the testicle may be pushed to one side. Rarely more than one cyst of this description may occur in a given instance. Such a cyst is called encysted hydrocele of the cord. Its walls are lined with serous membrane, and its contents are similar to those of vaginal hydrocele. Its occurrence is due to a localized non-obliteration of the folds of the serous membrane, which usually become obliterated at birth. It can be distinguished from inguinal hernia in those cases in which that affection is simulated by the following characteristics: It is transparent, flat on percussion; coughing produces no impulse in it; it is permanent, never disappearing or reappearing suddenly; and it is firm and non-compressible to the feel.

The rare condition already described as effusion of serous fluid into the loose subscrotal tissues about the cord, diffused hydrocele of the cord, can usually be readily differentiated by its shape and by the fact that its outlines are less well defined. The treatment advised is aspiration and carbolic-acid injection.

Spermatocele of the cord has been known to occur. Vautrin reports such a case and refers to several others. This condition, owing to its great rarity, simply merits mention in this connection.

Congenital Hydrocele.—When the knuckle of peritoneum drawn down with the testicle in its descent maintains a connection with the peritoneal cavity, that knuckle which makes up the tunica vaginalis becomes distended with peritoneal fluid, forming a tumor which is called congenital hydrocele. Such a hydrocele is prominent at birth and for a few months afterward. The connection between the two cavities, however, almost always soon closes, thus shutting off the cavity of the tunica vaginalis from that of the abdomen, and then after a time the fluid in the hydrocele is absorbed, a natural cure taking place. Before the connection between the two cavities is closed the hydrocele on being squeezed can be diminished somewhat in size, since a certain amount of its contents flows back into the abdomen. Congenital hydrocele need never be mistaken for a hernia, since, owing to the thinness of the scrotal walls in the young subject, its transparency is most apparent. This form of hydrocele generally gets well spontaneously. Its absorption, however, can often be hurried by a few pricks with a surgical needle. Injection with carbolic is not advisable, lest the inflammatory reaction caused by it extend upward into the abdomen in case the connecting passage should still be pervious.

Hydrocele of the Hernial Sac.—Rarely an old hernial sac may remain filled with abdominal fluid, its communication with the abdominal cavity having been more or less completely closed by omentum, bowel, and adhesions. Such a tumor is called hydrocele of the hernial sac. It should not, of course, be injected. False hydrocele of the hernial sac occurs in cases of strangulated hernia, where a serous effusion takes place between the walls of the sac and those of the incarcerated gut.

Hematocele.—This term as ordinarily applied refers to a tumor caused by a collection of blood in the cavity of the tunica vaginalis. It differs from hydrocele in that it is not transparent. Its advent is always sudden, thus corresponding to the hemorrhage which occasioned it. It is usually associated with some traumatism, and it is apt to be accompanied by some inflammatory symptoms if it has not existed for any time. Any variety of hydrocele as well as spermatocele may rapidly refill with blood after being tapped, thus forming hematocele. As has already been described, hemorrhage may take place into the loose tissues about the cord, forming a tumor sometimes called diffused hematocele of the cord. After what has been said regarding differential diagnosis with reference to hydrocele, nothing further on that subject is here necessary, since the remarks with reference to hydrocele refer in a general way also to hematocele. For treatment the sac should be incised antiseptically, the clot removed, the cavity irrigated, and drainage established and continued until such time as an obliteration of the sac by granulations has been accomplished.

Pyocele.—This name can appropriately be given to encysted collections of pus which occur generally in connection with the epididymis, rarely with the testicle and cord. Such collections are of the nature of cold abscesses. They are very chronic, develop slowly, and have no clinical inflammatory symptoms. They are generally tubercular, lined with a pyogenic membrane, and filled with cheesy pus, frequently of such thick consistency that it will not flow through any but a coarse aspirating needle. Oftentimes such cysts can be distinguished from a spermatocele or encysted hydrocele only by a resort to aspiration. The treatment advised consists of free incision combined with thorough curetting of the lining walls and the establishment and maintainance of drainage until the cavity is well filled with granulations. Iodoform suspended in glycerine often makes a very efficacious injection to stimulate healthy granulation in these cases.

Free bodies in the tunica vaginalis are rarely found closely resembling those occurring in the knee-joint.

Lipoma.—A tumor of this description occurs occasionally in the loose tissue in close relation to the cord, and may consequently resemble a cystic tumor of the part. An attempt at aspiration will always settle the diagnosis.

ANOMALIES WITH RESPECT TO THE TESTICLES.

A cryptorchid is one who was born and has remained without either testicle in his scrotum; a monorchid is a similar individual who has never had but one testicle. The study of the question of arrest of development, which accounts for these cases, falls beyond the scope of this treatise, and will consequently not be here considered. There are varying degrees in this arrest of development. When a testicle remains in the abdomen inside the internal abdominal ring, it is spoken of as *undescended* testicle. When it remains in the inguinal canal, at the external ring or just without the external ring at the top of the scrotum, it is spoken of as a *partially descended* testicle. It is very rare for a testicle undescended at birth to descend afterward. A testicle, however, partially descended at birth may in a short interval afterward work itself down into its proper position, especially if aided by artificial manipulation. Inguinal hernia often accompanies partial descent of the testicle.

A **misplaced testicle** is one which, although it has descended, has not entered the scrotum, but forms a prominence in the perineum or at one side of the scrotum in the inguinal fold (Figs. 65, 66).

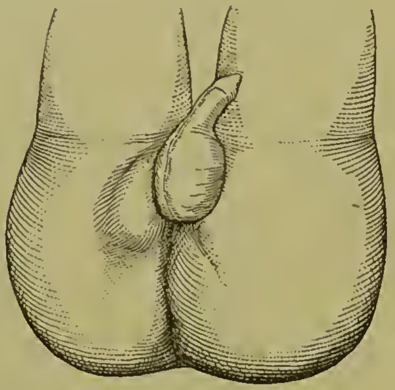

FIG. 65.—Misplaced testicle (Pollard).

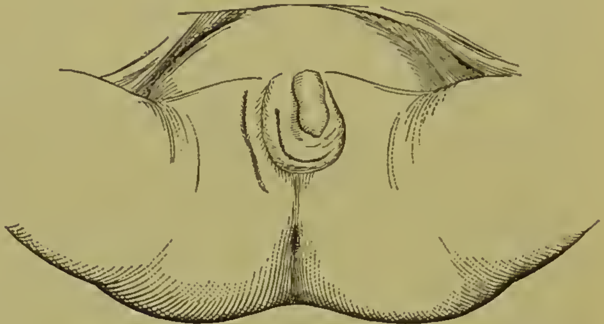

FIG. 66.—Misplaced testicle, after operation (Pollard).

Supernumerary testicles probably occur, since competent observers have reported such cases. Still, when an instance of supernumerary testicle is reported such a diagnosis can justly be regarded with some suspicion, since on careful investigation most of such cases prove to be wrongly diagnosed, the extra testicle turning out to be a cyst, a lipoma, or some morbid growth.

When a testicle does not descend, but remains either in the abdomen or inguinal canal, thus subjected constantly to outside pressure, it does not fully develop, but remains soft and incapable of secreting viable seminal elements. With a cryptorchid the penis does not fully develop, the hair on the pubes is scant and thin, and the general characteristics of such an individual are much like those of a eunuch who has lost his testicles at an early age. A monorchid suffers in no such manner, however, but may be sexually vigorous and potent. Sometimes this monorchid condition is inherited. If undescended testicles are brought down into their natural scrotal positions before the age of puberty is fully established, for instance from twelve to sixteen, the hitherto soft and withered organs oftentimes fill out, becoming of good size and firm consistency; and in case the individual has been a cryptorchid, these changes in the testicles are accompanied by erections, emissions, the awakening of sexual desires, and even by the ability to impregnate. Experiments on animals have also shown that retrograde changes of an opposite nature ensue in cases where the testicles are replaced and retained in the abdomen.

When a testicle is undescended it occasions the individual no localized inconvenience. When, however, it is partially descended it is a frequent cause of suffering and of danger, because, owing to the position of the organ with reference to the inguinal canal, it is exposed to many forms of traumatism. Every injury inflicted upon it causes much localized pain, the organ becoming swollen and occasionally gangrenous. Besides this, such a testicle, as the result of continuous traumatism, oftentimes undergoes malignant degenerative changes.

Orchidopexy is the name given to the operation which has for its object the bringing down into the scrotum of an undescended or partially descended testicle, the making of a scrotal nidus for its reception, and the retention of the organ in its natural position until firm healing has taken place. The first step in the operation, the securing the organ and bringing it down into place, is not difficult. If the organ is undescended, the inguinal canal has to be opened. If it is in the canal and cannot be forced out by manipulation, the external ring only has to be divided; otherwise the inguinal canal is not disturbed. The next step, making a scrotal nidus, often requires considerable dissection and stretching of the parts. It is the last step in the operation, however—namely, the retaining the testicle in its scrotal position—which is the difficult one. This is because the cord in connection with such testicles is undeveloped and consequently short, and also because there exists an elastic fibrous band, the gubernaculum, which is attached to the testicle and tends to draw it up. This fibrous band should always be carefully dissected away, so that there should remain only the shortness of the cord to contend against. If the testicle is only kept in position a certain period of time, the length of the cord soon corrects itself to correspond with the new position of the testicle. To prevent retraction the scrotal folds between the testicle and the external ring should be brought closely together by sutures, thus acting like buffers, as it were, while at the same time outside pads of antiseptic material should be so placed outside the scrotal folds as to aid those tissues in counteracting the pressure brought against them by the testicle.

Treatment.—If both testicles are undescended, no bodily harm comes to the patient from leaving them alone, and such has formerly been the advice in these cases. Since, however, a few brilliant results have been obtained in cryptorchids by the employment of orchidopexy, such an operation is advisable, certainly in selected cases, in order that those so afflicted may be able to marry and perform their sexual functions. In a monorchid, where the testicle is undescended, no surgical interference is advisable. In all cases where one or both testicles are partially descended palliative or radical surgical treatment is advisable. Palliative treatment is intended to get the testicle out of the inguinal canal and to keep it out. If a testicle is in the inguinal canal and cannot be pressed forward, then it should be pressed back into the abdomen and kept there by the application of a suitable truss. If it can be pressed out—and this is far better—that should be done, and a pad adjusted, if possible, at the external ring so that the organ cannot slip back, and the organ should be pulled down daily as nearly as possible into its scrotal position, so as to stretch and distend its cord and gubernaculum, in the hope that after a time it will stay in place. Much can be done by a careful and painstaking parent in so bringing a testicle into place, and often a perfect result can be thus obtained. If palliative treatment fails and the offending testicle cannot be kept out of the inguinal canal, where it is exposed to traumatisms, radical surgical measures should be employed. These consist of orchidopexy or castration. Orchidopexy of course is to be preferred in all cases where it is practicable. The best results from this operation have so far been obtained in boys of from ten to fourteen years of age. In very young children, where a radical operation is demanded, castration may be necessary, since the patient cannot well be prevented from tearing off and soiling the dressings, thus jeopardizing such an operation as orchidopexy. Where partial descent of the testicle is complicated with hernia, then both conditions have to be taken into consideration, and in doing a radical operation on the hernia the testicle is generally sacrificed, castration being employed.

The treatment for misplaced testicle is to put it in its proper place in the scrotum. To do this considerable dissection may oftentimes be necessary, but when the organ is once put in place, it generally tends to stay there, since no traction from a short cord, such as may interfere with orchidopexy, is to be expected.

Strangulation of the Testicle from Torsion of the Cord.—This accidental condition was first demonstrated a few years ago by Nicoladoni, since which time numerous examples of it have been reported, showing it to be not infrequent. It has been shown that torsion of the cord occurs chiefly in connection with testicles where descent into the scrotum has not been complete. In most such cases the gubernaculum by the traction it exerts seems to favor the torsion. In examining a case of this description the testicle will be found to have undergone several complete lateral rotations, thus tightly twisting the cord, together with its accompanying blood-vessels and nerves. The result of such torsion, if it is all complete or if it is not speedily relieved, is to stop all circulation through the testicle, strangulation resulting. The symptoms attending this condition closely simulate those of strangulated inguinal hernia, and in most of the cases so far reported it has only been after an incision has been made, with the expectation of discovering and relieving a strangulated hernia, that a strangulated testicle from torsion of the cord has been diagnosed. There are, however, differences which ought, especially if the case of torsion is seen early, to be sufficient to enable the surgeon to make a correct differential diagnosis, except perhaps in those instances where inguinal hernia occurs as a complication. Cases of torsion manifest themselves suddenly as a severe stabbing pain in the testicle affected. Such an attack of pain generally occurs during or shortly after some violent exercise. The scrotum on the side affected quickly swells, owing to an internal effusion of plastic lymph and serum. If the testicle is felt, it will be found to be more or less drawn up and to be quite rigidly attached to the cord. The cord cannot be distinctly felt, a thick tumefaction occupying its place. Oftentimes when the rotations have not been complete the epididymis will be felt in front of or to one side of the testicle, and not behind, as it should be. If the case is recent, so that complete strangulation of the testicle has not taken place, an attempt at lateral rotation of the testicle if in the direction of the torsion will serve to intensify the pain which the patient is already suffering by twisting the cord still more tightly. If, however, lateral rotation in the opposite direction is practised, then relief from the pain will be immediately experienced, since the twist will be loosened. In strangulated inguinal hernia, of course, the testicle can be felt natural and easily movable independent of the tumor. Vanderpoel has reported a case of torsion of the cord in which a moderate degree of torsion, but not sufficient to cause strangulation of the testicle, has occurred on numerous occasions. On each occurrence of the accident, however, natural relief had been experienced largely from a spontaneous retwisting of the cord.

Treatment.—If the case is seen early, before gangrenous changes in the testicle have been established, the torsion should be promptly untwisted. Nash has reported a successful case from prompt treatment of this description. If the testicle is already gangrenous, then the only treatment is to remove it promptly and to drain and disinfect the parts thoroughly.

Hemorrhagic Infarction of the Testicle.—This condition is of rare occurrence. It is to Englisch that we owe most of our knowledge on the subject. It is occasioned by a thrombosis in connection with the internal spermatic artery or the pampiniform plexus, or both these structures. The thrombosis seems in some cases to be caused by infection. A case of this description generally first manifests itself by symptoms similar to those of pelvic peritonitis. Then the scrotum, one or both sides, may be affected, swells greatly, presenting the appearance of phlegmon. This condition has also been observed in male babies shortly after birth, there having been a breech presentation. Expectant treatment is advised in all forms of the disease.

Variations in Size and Consistency of the Testicle.—Large-sized or firm testicles are found in those full of sexual vigor and activity. In individuals also who have but one functionating testicle, that organ is generally somewhat above normal in size. Anything, however, approaching great hypertrophy in a healthy testicle does not occur. In old age the testicle generally undergoes degenerative changes which reduce its size. These changes consist of fatty degeneration of the secreting epithelia and sclerosis in connection with the interstitial tissue. At what age these changes begin depends entirely on the individual, some men retaining their sexual potency until very late in life. Complete atrophy of the testicle is not rare. It may occur without any assignable cause, in which case some disturbance in the nerve-supply to the part probably exists. In such instances, while the atrophic changes are taking place, complaint is often made that the organ is painful and very tender to the touch, though no inflammatory signs are present. It is more common, however, for atrophy of the testicle to be found following closely after the subsidence of an inflammatory disturbance affecting the part. Orchitis due to mumps is a form of inflammation which is especially prone to be followed by atrophy. Operations for varicocele, for hernia, and occasionally the wearing of a truss which presses on the cord may all be followed by atrophy of the testicle, probably due to some injury which they have caused to the nerve-supply of the part. Then, on the contrary, the epididymis and a large part of the cord may be removed, and still the testicle which is left will usually remain permanently firm and of natural size. Where atrophy of the testicle is occasioned by a derangement of the nerve-supply, both organs are usually affected, provided the derangement is centered in the spine.

Neurotic sensations in connection with the testicles are common and may be due to a variety of causes. Thus the pain of a pyelitis, especially when it is due to calculus, is liable to be referred to the testicle on the corresponding side. The same is especially true also of the pain due to urethral obstruction. During the paroxysms of pain referred to the testicle that organ is frequently so retracted that it is held close against the external inguinal ring. Neuralgic pain in the testicle may also be a prominent feature in certain cases of seminal vesiculitis. More rarely vesical and deep urethral inflammations may be attended by such symptoms. Excessive sexual indulgence and long-continued sexual excitement without relief are among other not infrequent causes. Sometimes a testicle remains extremely tender and painful after the subsidence of an inflammatory process in connection with its substance. In these last cases the preceding inflammation has probably partially obliterated some of the secretory ducts, thus interfering with the function of the organ. In attempting to treat a neuralgia of this description great care should be exercised by the surgeon first to diagnose its cause correctly, for if the attention is simply centered on the testicle, efforts at relief are generally futile.

Traumatisms, by causing laceration of the scrotum, may lead to exposure of the testicle. The testicle itself may also be bruised or lacerated. Sometimes individuals suffering from melancholia or remorse mutilate or excise their testicles. If a testicle is simply exposed by an injury to its coverings, it suffers no harm. If its substance is badly bruised, subsequent atrophy is common. If the tunica albuginea is torn, the organ is destroyed unless the rent is such that it can be promptly sutured, since its secreting tubules by the force exerted by the cicatricial and natural contraction of the interstitial capsule protrude, forming with their granulations a fungous mass.

Castration is an operation which hitherto has generally been practised only to remove localized disease, unless it be in a few instances of operation for hernia where the cord might interfere with the result, and also occasionally to abate extensive sexual disorders. At the present time, however, double castration is being quite extensively employed with the intention of producing prostatic atrophy in old men suffering from the effects of prostatic senile hypertrophy. The results of castration in some of these latter cases have been brilliant, the prostatic hypertrophy largely or apparently wholly disappearing, and in some the results have been negative. So at the present time just what will be the outcome of this treatment in a given instance has not been determined. White of Philadelphia was the first to suggest castration for prostatic hypertrophy. To perform the operation a small longitudinal cut should be made in the scrotum above the testicle if the organ is not adherent to the parts. Then the testicle should be pushed through this elastic hole. The spermatic artery should be ligated by itself. The veins, however, can be ligated *en masse.* Then the cord should be divided, and also the blood-vessels below the ligatures, care being exercised not to allow the stump of the cord to retract up into the inguinal ring until it is evident that all of its blood-vessels have been securely tied. Temporary drainage should be provided until it is evident that no suppuration will occur. In young or middle-aged subjects, antiseptic precautions being of course carefully observed, the mortality after this operation should be almost *nil.* In old men, however, who are dependent on the use of the catheter the operation of double castration, according to White's statistics, is attended with considerable mortality. In a number of these cases death was from sepsis, the wound having become infected after the operation, probably from urinary dribbling consequent on the use of the catheter and from the frequent disturbance of the dressing which in some instances the catheterization necessitated. In a few of these aged individuals a marked mental disturbance was observed after the removal of the testicles, which occasionally was sufficient of itself to cause death.

INFLAMMATIONS OF THE SEMINAL VESICLE, THE CORD, THE EPIDIDYMIS, AND THE TESTICLE PROPER.

Pathology.—The great majority of inflammations involving the epididymis and testicle have their origin directly or remotely in the urinary tract, extending thence down the ejaculatory duct into the seminal vesicle, and from there still farther along the cord into the epididymis, and perhaps into the testicle itself, thus traversing the full extent of the genital tract. In order that inflammation of the urinary tract may involve the ejaculatory duct it must have extended into or originated in the deep urethra. Where the inflammatory process in the deep urethra extends along the ejaculatory duct into the vesicle, and from that organ promptly along the cord and into the epididymis, then the resulting epididymitis, as is evident, has originated directly from the deep urethral inflammation. This inflammatory extension from the deep urethra, however, is not always—and in fact very frequently is not at all—rapid in its extension. In many such cases the inflammation penetrating the seminal vesicle frequently sets up a chronic seminal vesiculitis. Then, after an interval perhaps of years, as the immediate result of some disturbing factor, the old inflammation in the vesicle, becoming exacerbated, suddenly extends down along the cord, setting up an acute epididymitis, the remote origin of which was the old inflammation of the urinary tract. As the old original inflammation has probably passed away, and perhaps been largely forgotten, and as the chronic seminal vesiculitis as such may not have been known to the patient or his doctor, it is natural that the cause which tended to stir up the chronic seminal vesiculitis, or, in fact, anything unusual which may have occurred just previous to the testicular inflammation, should wrongfully be ascribed as the source of the epididymitis. Thus it is that we commonly hear of epididymitis due to cold, malaria, sexual strain, alcohol, and what not. It must not be supposed, however, that an inflammation after it has once entered the ejaculatory duct must speedily or remotely invade the whole genital tract, or that it necessarily deals alike with the different parts which it does reach. Sometimes it spends itself on the seminal vesicle, setting up a very acute disturbance there which may end in perfect resolution, leaving the organ as good as ever it was. Then, again, it may treat the vesicle very kindly and transiently, but spend its fury on the epididymis and cord. When the cord is severely affected, however, the seminal vesicle is usually also much involved. It is not uncommon for the epididymis and testicle to escape largely in cases of extreme involvement of the testicle and cord.

Some forms of inflammation originate in the seminal vesicle, and from that focus may extend either downward along the cord to the epididymis and testicle, or outward, involving the ejaculatory duct and even the urinary tract. Lastly, the epididymis and testicle may be the source of inflammation. When the epididymis is the source, the inflammatory process may in some instances ascend the cord. When, however, the testicle proper is the source, the process does not ascend the cord, nor in fact apparently tend to involve the epididymis.

The forms of inflammation which may invade the genital from the urinary tract can best be classed as simple, gonorrheal, those resulting from urethral lesions originating from gonorrhea, and tubercular.

The forms originating in the seminal vesicles are simple and tubercular. Those originating in the epididymis are simple, syphilitic, and tubercular. Those originating in the testicle proper are simple, syphilitic, and rarely perhaps tubercular. There are a few inflammatory conditions, chief among which is that occurring in mumps, which it is impossible with our present knowledge to include in this classification. Such irregular conditions will be considered by themselves. It might be said that inflammations associated with neoplasms should have been mentioned. Neoplasms, however, together with their methods of extension, will be considered by themselves, and whatever true inflammation they may cause by their presence will be classed, as it should be, under simple inflammation, since it is in no wise characteristic of the neoplasm which it happens to accompany.[1]

The simple inflammations of the urinary tract which may secondarily invade the sexual apparatus by way of the ejaculatory ducts are such as may be caused by the passage of a sound or catheter along a healthy urethra. If a subject is young, such a result from the use of instruments in a healthy urethra is not very common. In an elderly subject, however, suffering from prostatic enlargement, it is frequent. Sometimes in prostatics, where there is much vesical tenesmus, the urethral inflammation may extend itself, even though no instrumentation has been employed. The same is also true where vesical calculi, gravel, polypi, etc. by reason largely of the vesical tenesmus they cause set up inflammation of the deep urethra. Perineal traumatisms by injuring the deep urethra may cause like results. The inflammations of the genital tract resulting from such causes are not apt to be severe. The vesicle becomes moderately swollen and its contents semi-purulent. Its walls, however, are but moderately involved, and it is very rare that the perivesicular tissues are invaded. The inflammatory process generally stops at the vesicle, but occasionally extends to the epididymis, setting up a light-grade inflammation which renders the part extremely sensitive, but which is not usually productive of much swelling. The cord is not apt to be swollen or tender. An exception to this description may, however, be sometimes observed in elderly prostatics who are being broken in to catheter life. In such cases, if the epididymis once becomes involved, the inflammation may be kept up and intensified by the continual use of the catheter, and the epididymitis may become so severe as to be purulent. It may extend to the testicle, setting up an orchitis, and the cord may become so swollen that it approaches the index finger in size. In such extreme cases incisions may be required to drain off the pus and the testicle may be destroyed.

Inflammations of the genital tract due to gonorrheal infection of the part are serious, not so much for the severe pain they may occasion as for the lasting lesions they may leave. Gonorrhea in the genital tract may run a rapid acute course, associated with great pain, or it may pursue a slow and more insidious one, associated with but little severe pain. The acute course is more rare. When it invades the vesicle, that organ become swollen to the feel and approaches the size of a goose-egg. On touching it through the rectum pain almost unbearable is experienced. The cavity of the sac is distended with pus, and its walls, together with the perivesicular tissues, are swollen and edematous. Sometimes this perivesicular inflammation is extensive enough to involve the neighboring pelvic peritoneum, thus setting up a localized process which has been known to have eventually become general. In a percentage of these cases of acute gonorrheal seminal vesiculitis the inflammation does not penetrate along the canal beyond the vesicle. Oftentimes, however, it does extend so as to involve the epididymis, but rarely, if ever, the testicle. In these cases the cord does not, as a rule, escape manifesting marked evidences of inflammation. It generally swells, sometimes to the diameter of the thumb. Under these circumstances the cord itself is not very sensitive, but it causes great distress by pinching the the nerves which accompany it in its passage through the inguinal canal. Its length also, owing to the swelling, becomes much shortened, thus tending to draw up the testicle toward, and in some extreme instances almost to, the inguinal ring. Occasionally in these acute cases, where the cord is the most involved, the inflammation in the epididymis may be very slight, but ordinarily the epididymitis associated with this acute gonorrheal condition is very intense. The epididymis may swell to such an extent as to appear double the size of the testicle, accompanied by a serous effusion into the tunica vaginalis, thus constituting an acute hydrocele. The scrotum also becomes thick and edematous. In extreme instances the scrotal tumor may nearly equal the size of a cocoanut. Such extreme size, however, can only occur when there is much serous effusion. Under proper treatment, which will be described later on, it is wonderful to observe the extent of the resolution which usually takes place in these very acute cases, especially with reference to the seminal vesicle. The common form of gonorrheal invasion, however, and the one really more to be dreaded owing to the lesions it leaves, is that which progresses slowly along the ejaculatory duct and into the vesicle, causing many functional disturbances, but comparatively little acute direct pain. It is in this form that the gonococci, as has been described by Finger, show a great tendency to penetrate the lining epithelia and even the subserous structures, degenerating, perhaps, and remaining at times more or less dormant, but existing there all the same, ready when some acute disturbance may arise to resume their active infectious qualities. Under the influence of this chronic gonorrheal process the epithelium lining the part of the genital tract involved loses largely its columnar qualities and becomes hard and pavement-like, and the subserous structures grow hard and sclerosed by interstitial proliferation. By a wise provision of nature, as demonstrated in the author's book (reference to which has been made), the ejaculatory ducts, by reason of their lying in a lymph-space, the infundibulum of the prostate, cannot become encased by plastic lymph—the way the urethra can, for instance—and consequently, although their lining membrane may be altered by a chronic gonorrheal process, no stricture of their canals can result. Although the author was the first to point out the reason for this peculiar exemption from stricture enjoyed by the ejaculatory ducts, Guelliot had previously called attention to the fact that the ejaculatory ducts apparently always remained free from occlusion, or, if occlusion had ever existed, that the fact had never been anatomically or pathologically demonstrated. With the seminal vesicle proper, however, nothing exists to prevent sclerous interstitial changes from taking place beneath the lining epithelium. Such changes oftentimes affect the interstitial tissue throughout the entire thickness of the vesicle-wall. When the inflammatory process is as extensive as this, it rarely confines itself to the vesicle-walls, but invades the perivesicular connective tissue. When such is the case the surrounding tissues are first invaded by an effusion of plastic lymph, which in extreme instances may be sufficient in quantity entirely to fill up the post-prostatic recto-vesical space. These tissues then show to the feel the presence of hard edema. This is a condition which one unskilled in the rectal feel almost invariably diagnoses as prostatic hypertrophy. After a time this plastic lymph becomes organized into hard sclerous tissue. This hard sclerous tissue is much less bulky, however, than the plastic effusion. Sometimes, generally in strumous subjects, gonorrheal perivesiculitis, be it chronic or acute, may be suppurative. This chronic gonorrheal process generally does not extend along the genital tract beyond the seminal vesicle. It may, however, involve the cord and epididymis. In such cases the cord is not apt to appear much if at all enlarged. The inflammation of the epididymis is less than in the acute gonorrheal condition just previously described, while at the same time it is more severe than would ordinarily be expected from a simple inflammation. There is almost never complete resolution in the part after gonorrheal epididymitis, a hard kernel of induration remaining in the tail of the organ, generally about the size of a pea, and sufficient in most instances to prevent spermatozoa from passing beyond it. Very rarely the testicle seems to become somewhat involved by an extension of this form of epididymitis.

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[1] It will be seen that the classification of inflammations in this connection is new and original. For a proper understanding of inflammatory processes in connection with the seminal vesicle, together with its ejaculatory duct and the vas deferens, it is advisable first to thoroughly study the anatomy of the part, together with its physiology, which last includes an explanation of the manner in which the testicular secretion reaches the cavity of the seminal vesicle, and also of the mechanism of ejaculation. As such considerations are beyond the scope of a text-book, those who desire to perfect themselves in these particulars, and at the same time make a special study of the derangements of the part, are referred to Dr. Eugene Fuller's book on *Disorders of the Male Sexual Organs*.

The inflammation resulting from urethral lesions originating from gonorrhea, which may invade the genital tract, is really of the same nature as simple inflammation, since the gonococcus has been eliminated from it, and consequently the lesions it may produce in the genital tract, being also similar, need no further mention.

Tuberculosis originating in the kidney, bladder, or urethra may, and frequently does, invade the genital tract. In fact, such is the common course of genital tuberculosis in the male. Tubercular inflammation in this connection may be acute, subacute, or chronic. The acute variety is not common. In a general way much that has been said regarding the pathological appearances and characteristics of acute gonorrheal inflammation in this connection can also apply to acute tuberculosis, with, however, the following modifications: The painful sensations are not apt to be so severe. The lesions, however, are more extensive and lasting than those caused by acute gonorrhea, and in many instances they are permanent, thus serving as foci for further inroads of the disease. In acute tuberculosis of the seminal vesicle the inflammation rarely confines itself to the sac and its walls, but shows a marked tendency to involve the perivesicular tissues. Such perivesicular inflammation may contain purulent foci. Like acute gonorrheal inflammation, it often extends along the cord into the epididymis. The epididymitis so caused, although representative of a severe grade of inflammation, occasions much less pain and tenderness than the corresponding gonorrheal variety. It does not extend into the testicle proper, but often suppurates, forming multiple abscesses, many of which finally coalesce. By this suppuration much of the scrotal tissue may become involved with burrowing abscesses, some of which discharge themselves externally, a fistulous opening presenting. This form of tubercular epididymitis may be accompanied by acute hydrocele. The tubercular process which extends from the urinary tract may be, and often is, subacute. This form represents a very mild grade of inflammation, and it is accompanied with few subjective symptoms. The walls of the seminal vesicle become moderately thickened. The feel, however, reveals but little tenderness. Such cases may end in resolution. This form of tuberculosis rarely, unless aggravated by some exciting cause, extends beyond the seminal vesicle.

Chronic tubercular inflammation extending from the urinary tract represents a severe pathological disturbance. Both the acute and subacute forms may become chronic, or the inflammation may start with features of chronicity. The chronic form, although not very painful except when subjected to irritation, is always accompanied by marked subjective symptoms. In connection with the seminal vesicle the inflammation always shows a marked tendency to involve the perivesicular tissues, filling in the post-prostatic recto-vesical space with a hard inflammatory extravasation, so that by the rectal feel it is impossible to define the posterior prostatic border. In severe cases this perivesical effusion may contain pus-foci. This form of inflammation generally extends along the genital tract beyond the vesicle. When such is the case the cord becomes thickened, always moderately and occasionally extremely. It is, however, but slightly sensitive to manipulation, though in extreme cases it causes much pain by squeezing the nerves accompanying it through the inguinal canal. The resulting epididymitis also is not acutely painful, the sensations from it being usually of a dull, dragging character. The epididymis at first becomes very hard and much enlarged. Then as the process progresses inflammatory exudates are generally thrown off into the surrounding tissues. These exudates, however, always maintain a firm attachment to the true periphery of the epididymis. They sometimes extend laterally, following the course of the parietal layer of the tunica vaginalis, thus forming thick lateral crustations which have given to the epididymis a feel which has been likened to that of a clamshell. When this condition of affairs exists, the cavity of the tunica vaginalis is distended with a chronic inflammatory effusion. In many instances this hydrocele has to be tapped before the true condition of the epididymis can be appreciated. After such a hydrocele has been tapped, it usually refills rapidly. After the chronic process has persisted for a time, pus-cavities form in the structure of the epididymis. Sometimes these pus-cavities dry up, leaving partially encysted cheesy foci, or, the suppuration becoming more active, it may extend beyond the capsule of the epididymis into the outlying inflammatory exudates. Pus-cavities here forming may coalesce, and there may be much burrowing, and finally the pus may discharge itself externally, fistulæ persisting. Oftentimes in these conditions pus may discharge itself into the cavity of the tunica vaginalis in case there has been hydrocele. If, however, hydrocele does not occur early in chronic tubercular epididymitis, it does not occur at all, since the cavity of the tunica vaginalis, if not distended, soon becomes obliterated by plastic adhesive inflammation as the disease progresses. The testicle proper is almost never involved in this form of inflammation, although from its being oftentimes apparently imbedded in the exudates from the epididymis it may deceive the surgeon into thinking that it is.

There is a form of compound inflammation which is frequently met with. It is usually severe and demands mention. This is where gonorrheal inflammation becomes grafted upon one of the grades of tubercular inflammation. In such instances the worst features of both forms of inflammation may predominate. Thus it is that tuberculosis is often said to follow gonorrhea. In many such instances a subacute tubercular process may have existed unnoticed, ready to be stirred into activity by the advent of the gonococcus. In a much less marked degree a simple inflammation, such as may follow the passage of a sound, may stir a slumbering tubercular process into activity.

Inflammations originating in the seminal vesicle may, as has been said, be simple or tubercular. Simple inflammations originate in some derangement in the mechanism of ejaculation. Such inflammations are at first of a light grade. They may, however, as the author has shown in his book, become severe, generally by reason of germ-infection. This infection may be introduced along the ejaculatory duct or it may come from the rectum, the germs passing through the intervening tissues, as Reymond has shown they can do. In such cases the bacillus coli commune is the germ often causing the infection. Simple inflammation of this character can extend along the cord, and involve the epididymis in exactly the same manner as simple inflammation the source of which was from the urethra.

Tubercular inflammation can apparently originate in the seminal vesicle. The author has observed a number of cases in which evidences of a tubercular character have been detected in a vesicle before any similar evidences have been discernible in connection with the urinary tract or elsewhere in the genital tract. On keeping these cases under observation, however, evidences of an extension of the disease to the urinary passages or epididymis have been noted. After what has been said regarding tubercular extension in the preceding connection, no further notice of it is here necessary, since the pathological appearances are alike in both instances.

Simple inflammation arising in the epididymis is always due to traumatism from without. It is rarely severe, although, of course, its intensity depends much on the natural violence of the traumatism. Such inflammation in this part is very rare. It is not rare, however, for some violent exercise to cause an epididymitis from the extension to that part of the inflammation in connection with a slumbering seminal vesiculitis. Without careful examination such an epididymitis from extension may be easily mistaken for simple primary inflammation of the part.

Syphilis may attack the epididymis, and when such is the case this disease does not reach the organs by an extension from some other part of the genital tract. Syphilis in this connection may appear in its secondary or late stages. Secondary syphilis of the epididymis is not rare. As, however, it occasions little or no inconvenience during its continuance, it usually escapes notice. It was first described by Dron. It usually appears in the third or fourth month of the disease, and, like the secondary cutaneous lesions, it is only temporary, and when it disappears leaves behind no evidences of its previous existence, being in this respect different from the gonorrheal inflammation. It generally involves the head of the organ, appearing as a hard, movable, insensitive lump, varying in size from that of a pea to that of a hazelnut. It is not unlike oftentimes, to the feel, the induration left after a gonorrheal inflammation, except that such an induration, besides being fibrous and permanent, is situated also in the tail of the epididymis. Late syphilis in connection with the epididymis is rare. As, however, its lesions, when it does occur, are serious and apt to be confounded with tuberculosis or cancer, the fact that it may be found in this part should always be kept in mind. It generally occurs after the completion of the second year of the disease. The epididymis becomes greatly enlarged and very rough to the feel, owing to masses of adhering inflammatory exudates. These exudates, however, are generally thrown out mostly laterally, involving for a considerable distance the parietal walls of the tunica vaginalis, the cavity of which is always filled, so far as has been observed, with effusion, thus causing hydrocele of considerable size. Sometimes the fluid drawn from such hydrocele is clear and serous. Oftentimes, however, it is bloody. After the fluid has been partially drawn off, then the characteristic feel of the epididymis is apparent, with its thickened lateral projections into the walls of the tunica vaginalis. Such an inflammation is not painful or sensitive. It does not involve the testicle proper. Oelsnitz and Ozenne, pupils of Reclus, as was mentioned in the author's article in *Morrow's System*, were the first to describe this form of syphilis. These writers, however, thinking from the thickened condition of the parietal walls of the tunica vaginalis that the disease originated there, thus overlooking its primary source in the epididymis, entitled their article "Syphilitic Pachyvaginalitis." The syphilitic process in these cases may be gummatous. It may so closely resemble a tubercular process or malignant disease that a differential diagnosis can only with certainty be made by a resort to antisyphilitic measures. Tubercular disease may rarely originate in the epididymis, in which case it may remain localized, or, what is more to be expected, extend upward along the cord and into the cavity of the seminal vesicle. The lesions it may produce in the epididymis when so arising differ, however, in no wise from those already described in connection with this disease when its source has been from above.

Inflammation arising in the testicle itself is rare except when due to syphilis. Interstitial and degenerative changes, as have been seen, occur in old age, but such changes consequent on natural decay can hardly be said to cause orchitis. Simple orchitis when originating in the testicle may occur spontaneously, no well-defined cause existing to account for it. When it so occurs, however, the individual is usually suffering from general debility. It may sometimes develop during the course of a septic fever, such as typhoid. Gout may rarely cause it, in which case the inflammation is largely peripheral, consisting of the characteristic gouty inflammatory changes in connection with the visceral portion of the tunica vaginalis. Traumatisms may also, as have been seen, cause an orchitis. When orchitis is at all acute (whether it originates in the part itself or is transmitted there makes no difference) severe localized pain and tenderness are present. This is owing to the fact that the dense fibrous sheath, the tunica albuginea, which envelops the organ, prevents its medullary substance from swelling, as it naturally would at the onset of the attack, the result being great engorgement. For this same reason the organ when so involved, especially in the early stages of the attack, remains little altered in size and shape. It is, however, extremely hard, and the least manipulation gives rise to intense pain. The epididymis, except of course in transmitted cases, remains natural. After the attack has existed for some time the visceral portion of the tunica vaginalis becomes inflamed, the result being usually an adhesive inflammation of the whole sac, thus causing its obliteration, or more rarely a serous effusion causing hydrocele. Resolution in these cases may be very slow and tedious. The organ, after being hard, dense, and somewhat enlarged for a considerable interval, may gradually become smaller and smaller, and finally atrophy; in which instances there are to be found fibrous contraction of the interstitial connective tissue associated with fatty degeneration and absorption of the secreting structures. Sometimes, however, the primary engorgement stage is followed by abscess-formation, in which case the abscess or abscesses, remaining confined in the central portions of the organ, may after a time become encysted in fibrous sheaths and gradually absorb, leaving cheesy or calcareous foci to mark their previous positions. At other times, however, the collection of pus may gradually work its way to the surface of the organ, and finally succeed in breaking through the capsule. While this process of perforation has been in progress adhesive peripheral inflammation has obliterated the sac of the tunica vaginalis, so that the pus escaping through the tunica albuginea forms a soft fluctuating scrotal area over the point of its escape. In a comparatively short time after escaping from the testicle the pus succeeds in discharging itself through the scrotal wall, leaving a sinus which may persist for a long time unless atrophy of the testicle ensues. Sometimes in a given instance the scrotum and testicle may be riddled by such sinuses. Frequently a bunch of granulations may be heaped up over the sinus opening, and sometimes some of the medullary substance of the testicle may protrude, forming a so-called hernia testis. In simple inflammations, however, hernia testis is rare. Simple orchitis, which is chronic in character from its commencement, is rare, and may be dependent on some dyscrasia, such as occasions arterio-sclerosis in cases where senility and syphilis can be excluded as factors.

Orchitis is sometimes said to occur in the new-born, especially after breech presentation. In these cases it is probable that hemorrhagic infarction, as Englisch has observed, rather than inflammation, is the cause of the swelling, and hence the term orchitis is a misnomer.

Syphilitic orchitis is a late manifestation of the disease, and its occurrence in this part is not rare. It may assume two forms, the interstitial and the gummatous. In the interstitial form the testicle at first becomes enlarged, generally to about double its normal size. The process of enlargement, however, is slow and occupies many months and sometimes a year or more. It is not a painful condition, and, aside from some discomfort caused by the dragging attendant on the increase in size of the organ, it rarely occasions complaint. The condition is frequently accompanied by moderate hydrocele, although at times the cavity of the tunica vaginalis is obliterated by plastic adhesions. In the first stage of this form of orchitis there is a connective-tissue proliferation associated with plastic exudation. The organ becomes very hard and non-sensitive. After a time sclerous connective tissue takes the place of cellular proliferation and plastic exudation. The organ decreases in size, so that it usually becomes much smaller than normal, and so remains hard, fibrous, and non-sensitive. The hydrocele, should one have existed in the earlier stage, also disappears. In the gummatous form, the condition the better recognized in literature, the testicle affected generally becomes in the early stage much larger than in the interstitial variety. It may reach the size of an orange, though that of a lemon is more usual. In this condition also there is little or no pain or tenderness. Hydrocele may or may not coexist, just as is the case with the other variety. The testicle is not so hard to the feel as in the interstitial form, and it seems somewhat edematous. It is usually regular in outline, preserving sometimes the natural contour, although it is often more spherical. As the gummatous process develops it works its way from the medullary portion of the organ, its starting-point, to the periphery. The central portion of the gumma breaks down into a liquid mass, and perforation of the tunica albuginea takes place, just as we have seen sometimes occurs with abscess of this part. Before this perforation occurs, however, the plastic lymph thrown out ahead of the advancing process serves to obliterate the sac. Consequently, after the perforation a localized soft, fluctuating area appears under the involved portion of the scrotum. There is no heat, no tenderness, nor, in fact, any evidences of inflammation in connection with this fluctuation other than redness. After a time there is perforation of the scrotum associated with a discharge of glairy material characteristic of gumma. Then, eventually, if the process is allowed to run its course, a red fungous mass appears protruding from the hole made by the perforation. This mass if examined will be found to consist of true medullary testicular structure covered with granulations. This protrusion is due to the fact that the secondary sclerous changes in the capsule of the testicle caused by the gummatous inflammation, by reason of the contraction which they exert, squeeze out most that remains of the secreting structure after the gumma discharges itself. Hernia testis and benign fungus of the testicle are terms often applied to this condition, which is encountered now much less frequently than formerly, since its course of destruction is generally stopped by treatment. These syphilitic changes are seen occasionally in boys who have inherited the taint.

A tubercular process (barring miliary tuberculosis, which is largely a general condition) which originates in the body of the testicle is certainly very rare. In numerous cases of tuberculosis of the epididymis associated with suppuration and burrowing of pus the testicle proper may eventually become so obscured by being buried, as it were, in the inflammatory exudates originating from the epididymis that it may appear to be not only involved by the disease, but even the source of it. If, however, in such an instance the inflammatory mass be incised and explored, the testicle itself when cleared of the surrounding débris will be found to be natural in size, consistency, and structure. Hence in such instances, as will be seen in studying treatment, the testicle proper can often be spared in an operative procedure, the epididymis, cord, and surrounding indurations alone requiring to be sacrificed.

There are a few inflammatory agents, as has been said, which attack the genital tract in a manner which is at present but little understood. Chief among these is mumps. Formerly it was taught that this disease when it involved the genital organs confined itself to the testicle proper. Now, however, there is reason to doubt this fact. Catrin, who has studied this subject probably more thoroughly than any one else, since he has investigated 159 cases, asserts that the inflammation begins in the epididymis and that the testicle proper is attacked secondarily. The author has seen a case of this disease where the seminal vesicle shared with the epididymis and testicle in the inflammatory process. It is certain, however, that the body of the testicle is the part most severely dealt with when this disease involves the genital organs. The orchitis so caused is often of a severe grade, although suppuration does not occur. The organ becomes much enlarged, so that with the scrotal effusion and edema it may attain the size of an orange. It is extremely tender and painful, and accompanied oftentimes by considerable general disturbance, such as high fever and occasionally delirium. After the subsidence of the inflammation atrophic changes in the testicle frequently occur, resulting in its complete destruction. With regard to complete atrophy, however, Catrin holds that it is less common than is usually supposed. He also considers that in many of these cases a partial atrophy occurs, which, however, is only temporary, the organ after an undetermined period of time regaining its former size and consistency. When atrophy does not occur after mumps the testicle generally is uninjured as regards its secreting function. Orchitis is every now and then reported to occur in the course of fevers of various kinds, rheumatism, gout, etc. Idiopathic orchitis, so called, has also been written up. In many such instances, however, as has already been mentioned, it is probable that the affection of the testicle, be it epididymitis or orchitis (many medical writers often confound the two), has probably resulted from an inflammation which has extended down the cord, its source having been a slumbering seminal vesiculitis which the general febrile or some other disturbance has stirred into activity. At any rate, by careful examination the non-existence of seminal vesiculitis should be determined before a case is reported as one of spontaneous orchitis occurring either as the result of some general disturbance or idiopathically. When this is done, it will be found that these cases of orchitis indefinite as to cause will greatly decrease in numbers and frequency.

Subjective Symptoms.—In describing the pathology of the appearances presented by the inflammatory conditions just considered, mention has always been made of the accompanying pain and tenderness, aside from which little has been said regarding subjective symptoms. Some of these inflammations are quite barren of such symptoms, and consequently demand little attention in this particular, while the reverse is true of others. Inflammations of the epididymis and testicle can, as a rule, be said to give rise to few symptoms aside from the direct pain and discomfort they may occasion. On the contrary, inflammations of the seminal vesicle when not acute are often accompanied by very many subjective symptoms, but by no localized pain or tenderness. The intense pain in an orchitis is generally localized in the testicle, and is not relieved by supporting the part, while with an epididymitis support by a properly fitting bandage is often very grateful. In epididymitis also the pain often radiates upward into the corresponding groin, and sometimes still farther into the flank. During acute inflammation of these parts sexual desire is generally *nil*, but otherwise that function is not affected. In chronic epididymitis there is often complaint that sexual excitement or activity is followed by a dull congestive pain in the affected testicle, supposed to be due to the fact that the secreting function of the organ has been stirred into activity, while at the same time the old inflammation, by obliterating the efferent ducts, prevents any of the secretion from finding a way out. This theory is probably well founded, since it has been observed that the secreting substance of a testicle does not atrophy, no matter how long its efferent ducts may be blocked. When an inflammation is associated with an intense degree of pain centered in the inguinal region, and from there radiating down the thigh and to a less degree upward into the flank, a marked swelling of the cord is generally found, the pain being caused by the pinching of the nerves which accompany that body along the inguinal canal. In acute epididymitis or orchitis there is generally considerable fever during the active stage of the disease, but in the chronic forms of inflammation there is little or no rise of temperature unless it be rarely in instances where there is suppuration.

In acute seminal vesiculitis the symptoms presented are almost wholly those due directly to the inflammatory process. In the early stages of the inflammation priapism and other evidences of excitement of the sexual center are often present, but as the disease progresses these generally disappear. There is often a great throbbing pain in the perineum or rectum, increased if the patient sits or walks, and partially relieved if he lies down, especially on his abdomen or sides. There is much tenderness in the suprapubic region corresponding to the side on which the vesicle is situated, and in very severe cases there may be a localized peritonitis in this part. Such peritonitis has in a few recorded instances become general, thus causing a fatal result. The bladder-functions are generally disturbed, especially during the early stages of the inflammation, the symptoms being frequent and painful urination, together, oftentimes, with evidences of spasmodic stricture. When the disease is on the increase, as indicated by the unabated continuance of fever, the urine voided is usually clear or nearly so. Then as the fever drops and the acute pain decreases the urine will be found to be loaded with pus, caused by a natural discharge along the ejaculatory duct. This purulent condition of the urine continues for some time until the sac is pretty well drained. Should the patient have in convalescence an involuntary emission, as sometimes happens, the ejaculated mass is apt to be tinged more or less with blood and the act is accompanied with a sensation of pain.

In subacute and chronic seminal vesiculitis during periods of exacerbation there may be painful sensations of a mild grade, much as have just been described as associated with the acute form of the disease. In very many of these chronic forms of inflammation, however, the associated painful sensations are slight, and in a certain percentage of them there exist no painful sensations at all. Oftentimes symptoms of pain and discomfort caused by the disease may be so reflected as to be associated in the patient's mind with other parts. Thus painful sensations in one or both testicles, in the scrotum, cord, along the urethra, at the end of the penis, in the bladder, and even in the pelvis of the kidney, may be complained of. The rectum, coccyx, and small of the back may likewise be the seats of such pain. The author has seen instances where pain due to seminal vesiculitis has so closely simulated intestinal colic and sciatica as to mislead able practitioners. Numerous and varied bladder and urethral symptoms may be thereby caused. Thus the urinary act may be made frequent, urgent, and painful. Then, again, it may be inhibited, it being impossible at times to urinate at all or at best only drop by drop. After the urinary act has been thus inhibited for several hours, the spell may all of a sudden pass off, the result being a full, free stream. If these cases are carefully watched, it will often be found that the vesical symptoms, such as have been described, are most intense after sexual excitement. Then, again, inflammatory symptoms may exist in connection with the urethra chiefly, less often with the bladder, which are dependent entirely on an associated seminal vesiculitis. Some time since in a thesis the author demonstrated these interesting facts. In such cases an urethral discharge or vesical pus will be found, there being no lesion in the urethra or bladder to account for the inflammatory evidences, and no amount of treatment directed toward the urethra and bladder will be found of any avail in curing the inflammatory evidences. As soon, however, as a cure of the seminal vesiculitis may be effected, then these associated symptoms will be found to disappear permanently. Rarely the urethral discharge in such instances may be of such a severe grade as to be bloody. In some instances where seminal vesiculitis has become infected by a foreign germ, as the bacillus coli commune, the bladder may also become infected. When such is the case, it will be found impossible to rid the bladder of the germ-infection until after the focus of infection in the seminal vesicle has been eliminated. Then, when this has been accomplished, the germs will disappear spontaneously from the bladder if that viscus be in an otherwise healthy condition.

Another fairly common complaint in chronic seminal vesicular disease is that, after straining at stool, especially over a hard, bulky movement, there is apt to appear at the meatus a mass of glairy, sticky material.

In this class of affections, however, derangements of the sexual function are most marked and furnish the most important group of symptoms. When the disease is not of very long standing the active evidences of irritation usually result in symptoms of sexual excitement, such as an undue amount of erections associated with an increase in sexual desire. Anything the least suggestive will be sufficient to excite the sexual center. Involuntary emissions are in such conditions frequent, often occurring by day. These emissions are generally followed by a feeling of discomfort locally and by depression generally. They may sometimes cause acute perineal pain. They lack force, and the amount of material ejaculated at a given instance is small. In some extreme instances there may be a feeling of ejaculation without any result, no fluid appearing at the meatus. If in such cases sexual intercourse be attempted, there is usually a premature ejaculation, accompanied sometimes with pain and followed by failure of erection. In all such cases, however, whether there be premature failure or not, little satisfaction is obtainable from the act, the sexual craving still persisting undiminished by the sexual attempts. As the case becomes more chronic feelings of sexual weakness grow more pronounced, and after a time there may be positive impotency. As the erections grow weaker and finally fail, so also do the sexual desire and craving, together with a cessation from emissions. In a small number of instances potency may persist apparently unimpaired, although sexual desire and satisfaction may be lessened. In a few cases the sexual function remains undisturbed.

The character of the seminal fluid is altered in chronic seminal vesiculitis. It is often purulent and stained with blood. In other instances, where the inflammation is very quiescent, it may be thick and jellified. In most cases the spermatoza which it may contain are dead on ejaculation. Neurotic sensations, some of them curious and indefinite, are often caused by seminal vesicular disease. Thus complaint is frequent that the penis is shrivelled, bloodless, cold, numb, etc. The testicles are often retracted and supposed to be atrophying. Bad feelings in the head and sometimes sharp headaches may occur after all sexual excitement. Mental depression and melancholy are common in aggravated and long-continued cases of this disease. The disposition may change, a placid person becoming irritable and quarrelsome.

The study of mental conditions dependent on seminal vesiculitis is very important, and a clear distinction should be made between such cases and those in which a psychological derangement is accompanied by sexual symptoms, there being no disease of the sexual apparatus.

The symptoms and evidences derived from the digital feel per rectum are most important, not only in determining the grade and nature of the existing seminal vesiculitis, but also in differentially diagnosticating it from other affections. To be skilled in this feel the finger of the genito-urinary surgeon requires fully as much education as does that of the gynecologist in the vaginal touch. The finger of the beginner reveals nothing to its owner. The only way to become skilled in this respect is to practise the feel repeatedly under careful instruction. The finger should first become familiar with the feel of normal conditions in order later on to appreciate what is abnormal. To practise the rectal feel the patient presenting himself with a partially or wholly distended bladder should while standing straight bend his body forward from the hips, so that he assumes what the author has called the "leap-frog" position. A fore finger of the surgeon is then well lubricated and introduced as far as possible into the rectum, considerable force being used by the remaining closed portion of the hand to overcome the resistance of the perineal muscles in cases where these structures are rigid. During this time counter-pressure is maintained with the free hand against the lower abdominal wall in order to bring the seminal vesicles into easier reach of the fore finger. By so doing the various inflammatory conditions of the vesicles, such as have been already described, can be mapped out and appreciated. In case the finger detects evidences of vesicular disease, then the author's method of stripping the vesicle should be employed in order that a specimen of the contents of the sac may be obtained. In order to do this the tip of the fore finger, after reaching along the body of the vesicle as far as it is possible, is bent downward and then slowly but firmly withdrawn along the line of the vesicle and of its ejaculatory duct. The counter-pressure exerted by the free hand on the suprapubic region acts as an aid to this manipulation. The vesicle may be stroked in this manner several times by the finger-tip in order that the stripping may be thorough. As a result of this stripping the pathological contents of the sac are forced out along the ejaculatory duct into the prostatic urethra, from which part, if the expressed fluid be abundant, it flows along the urethra and finally drips from the meatus. After the stripping the urine should be voided into a glass. The urine thus passed will show evidences of the expressed seminal material. It is a good plan before the stripping for the patient to pass a little urine in a glass, so that this, a natural specimen, can be compared with the one containing the expressed seminal fluid. When the contents of the seminal sac are largely purulent, the specimen of urine passed after the stripping will appear more or less cloudy, while that passed before the manipulation may be wholly clear or much less purulent. Where the vesiculitis is quiescent or very chronic there may be no purulent elements in the contents of the sac, in which cases the expressed material will appear in the urine voided after stripping as a partially transparent jelly-like mass, some of which may be globular and some cylindrical. Such cylinders are moulded in the ejaculatory duct. This jelly-like condition of the expressed seminal fluid lasts, however, but a few moments in the urine, since the acidity of that liquid quickly serves to dissolve it. There are many grades in the quality of the expressed seminal fluid between the purulent and the jellified conditions, but such gradations cannot here be specially considered. Blood may be mixed with the vesicular material, in which instances it lends its characteristic coloring to the material appearing in the urine after stripping the sacs. If the bleeding is recent, the coloring is red, its intensity depending on the quantity of blood-pigment. Where the hemorrhage is not recent, then a brownish discoloration takes the place of the red. Degenerative changes in connection with pus may likewise cause greenish tinges in purulent vesiculitis. Oftentimes also, especially after purulent conditions, shreds made up of vesicular epithelial desquamation occur among the expressed material. A microscopical examination should be made in these cases in order to demonstrate the presence of spermatoza. Sometimes in light forms of simple inflammation of the ejaculatory duct there will be seen in the urine passed after stripping the vesicle a transparent flake, which floats just under the surface of the urine. In stripping, the apex of the vesicle is beyond the reach of the finger-tip in many instances; still, in most cases, after some practice, the main cavity of the sac can be evacuated. A perfectly healthy vesicle is so freely movable under the finger and its walls, as well as those of its ejaculatory duct so contracted, that little of its contents are forced out by stripping. In such cases the urine passed after stripping is usually slightly amethyst in color.

When one has perfected the digital rectal feel, together with the process of stripping the seminal vesicles, he is able positively to diagnosticate seminal vesiculitis in cases where from the existing subjective symptoms the disease may have been suspected, and at the same time to exclude numerous conditions of the prostate which it might be impossible otherwise to differentiate. Thus also psychological conditions, functional impotence, hysteria, and sexual weakness due to general debility can all be differentiated from seminal vesiculitis. Chronic pyelitis is a disease which may sometimes require to be differentiated from chronic seminal vesiculitis associated with a purulent condition of the urine, since a small amount of albumin frequently exists in the urine in both disorders. The rectal feel here will determine much, since in pyelitis it should be normal. Then, again, in chronic seminal vesiculitis associated with purulent urine the purulency of the urine which is voided after stripping will be increased in the case of chronic seminal vesiculitis, while it will remain unaltered in the case of chronic pyelitis.

Treatment.—**Acute Orchitis.**—In this affection the patient should be promptly put to bed. He should lie flat on his back, and his testicles should be so elevated and supported that they rest on the pubic bone. The object of this position of the body and of the testicles is to reduce to a minimum the blood-tension in the inflamed organ. This is a most important feature in the treatment, since sudden engorgement of the part is to be feared, owing to its close confinement within the firm, inelastic tunica albuginea. To maintain this position of the testicles a firm band should be secured about the waist, and from this a strip of muslin about 3 to 4 inches wide should be attached anteriorly in two places, so as to form a loop the lower portion of which includes the testicles in their suprapubic position. From the lower dependent portion of the loop two back-straps should be fastened. These should extend outside the nates on either side and be fastened laterally to the waistband. This is done in order that the loop may not slip up, thus allowing the testicles to drop. A lateral strip of muslin is also often required to be fastened across the upper portion of the apex of the loop in order that the testicles may not slip over the support. As the organ is very tender in this affection, it should in all cases be protected from direct contact with the loop of muslin. Consequently, the loop should be lined with some soft yielding material. Lamb's wool is the best substance for this purpose, owing to its inherent elasticity. To combat pain, which is always severe, a hypodermic of morphine is often called for when the patient is put to bed, after which time it should be given as occasion may require. Local soothing and narcotic applications are frequently useful. Laudanum or tobacco stupes, or both combined, often prove very beneficial. To prepare these, laudanum or a strong tobacco infusion is sprinkled over a flannel which has been wrung out in hot water. The flannel is then wrapped about the testicles, a piece of oiled silk being slipped around it in order to get the full narcotic effect and at the same time to protect the wool and the bandage. These stupes should be changed every few hours, and if efficacious should be continued till the severe pain subsides. Belladonna ointment spread on a cloth and applied about the testicle may also be found very useful in subduing pain. Poultices should be used with caution, for they may by increasing the engorgement of the organ cause trouble. Sometimes very hot poultices used for a few hours early in an attack may by their direct heat produce comfort and do good. A longer continuance of such treatment, however, may cause a recurrence of pain and an increase of congestion. Formerly leeches were recommended to be applied at the onset of the affection in the region of the external abdominal ring. Many authorities recommend in cases where pain still persists in spite of palliative measures several incisions of less than one-quarter of an inch or so in length through the tunica albuginea in order to relieve internal tension and thereby prevent impending gangrene or suppuration. Such incisions are made with a fine bistoury through a narrow scrotal puncture. It can be argued against this procedure that more or less of the testicular structure may force itself out through the cuts in the capsule, and that thereby the testicle itself may be severely injured. Still, as the procedure is done to avert still greater evils which threaten, and as it serves besides to alleviate pain, it is to be recommended, although great care should be observed not to make the cuts into the testicle any deeper than is necessary in order to sever the capsule. If suppuration occurs, incision and drainage are recommended. The incision should be made as soon as fluctuation appears, in order, if possible, to avert extensive burrowing of pus. In spite of prompt treatment, however, the testicle generally eventually atrophies in case suppurative processes have once been established. When gangrene occurs a free incision should be made through the scrotum and the testicle removed. Castration is also advised in suppurative conditions where burrowing persists in spite of attempts at drainage.

Chronic orchitis is in the great majority of instances syphilitic in nature, as has already been seen, and consequently the treatment it should receive when of that origin is such as is appropriate for any late syphilitic manifestation. Iodide of potash or some salt of the iodide should be administered in doses of from 30 to 100 grains daily, combined with or in conjunction with a mercurial. After apparent resolution has taken place in the testicle, as is often the case, provided treatment has been recommended before the syphilitic process has caused actual destruction of tissue, the iodide can be omitted. A mercurial, however, should be continued for six weeks to two months after the stopping of the iodide. No matter at how late a stage a syphilitic testicle comes under observation, no surgical interference is warrantable until the patient has had the benefit of a thorough antisyphilitic course such as has been advised. After a course of this nature no surgery will be necessary, aside possibly from the removal of granulations in cases where there is benign fungus. If a chronic orchitis persists unaffected by an antisyphilitic course, then castration is advisable, lest some malignant growth may graft itself on the inflammatory process.

Chronic suppurative conditions which have originated in an acute orchitis have already been considered. In the rare instances where the testicle proper is affected secondarily to the epididymis, treatment should be directed toward the epididymis.

Acute Epididymitis.—Where this disease arises from a simple inflammation or from one remotely due to gonorrhea it is apt to be of a much milder grade than when due directly to gonorrheal infection. In such mildly acute cases, if the testicles be promptly supported by a well-fitting suspensory bandage and if the patient keeps reasonably quiet for a few days, the epididymitis will oftentimes speedily subside. In gonorrheal cases, however, it is always different, and when once the epididymis is attacked the inflammation becomes severe. In such cases, if it is possible, the patient should be put to bed, the testicles being maintained resting on the pubic bone, just as has been described in the treatment of acute orchitis. By so doing not only is the blood-tension reduced to a minimum, but all drag is also removed from the inflamed cord. A hot flaxseed poultice, a little powdered slippery elm being added, should be so applied as to envelop the affected testicle. It should also be made long enough to cover the inguinal region on the affected side, and even also the corresponding suprapubic region should there be much tenderness along the line of the cord. A half ounce of fine-cut tobacco may be added to each poultice in case the pain is very sharp, although the simple hot poultice is generally sufficient of itself without being medicated. Morphine hypodermically may be required at the commencement of the attack. The epididymis generally continues to swell for three days. At the end of that time the tenderness is much less, and if the testicle has been properly supported the pain ought to have disappeared. The poultice can then be omitted, lamb's wool being packed about the scrotum. The patient ought to be kept in bed for several days after the poultices have been discontinued, and when he is allowed to get up the testicles should be kept firmly supported and packed in wool. The wool packing should be gradually removed. Drag, however, should be kept from the cord for a considerable interval until all the evidences of inflammation save the permanent induration in the epididymis have disappeared. This can be accomplished by means of a suspensory bandage. In such cases, however, it is not sufficient for the surgeon simply to order the patient to provide himself with a suspensory bandage. The bandage should always be examined by the medical attendant in order to determine that it really performs its duties. In cases where the treatment just described can be thoroughly enforced little else is generally necessary. Many individuals, however, cannot lie up at all or at best only briefly. In such cases poultices, of course, are out of the question. The testicles should in these instances be packed in wool and firmly supported. The same local anodyne applications may be here useful as have been described under the treatment of Acute Orchitis. Very many other substances have also been advised to be applied locally in order to produce an anodyne effect. In fact, hardly a year passes without the appearance of a new remedy to accomplish this result. Among such new drugs recently recommended for this purpose are ichthyol and guaiacol. In severe inflammations accompanied by acute hydrocele much relief from pain may often be obtained by aspirating the hydrocele. Pain can also be speedily relieved in some instances by stroking very quickly and gently the tense scrotum over the affected area with a white-hot Paquelin cautery. Sometimes painting the scrotum with a 10 per cent. solution of nitrate of silver will accomplish the same result. Many times these and various other pain-killing devices are reported as methods to effect a quick cure of epididymitis. The word *cure*, however, in such instances is evidently wrongly applied, since a cure is not effected until the inflammatory products have been absorbed. In some instances hot poultices are not soothing in their effect and cannot be tolerated. In such cases pressure directly applied to the testicle may be productive of great relief from pain, and at the same time hasten the absorption of the inflammation. Such pressure may be applied by means of strips of adhesive plaster, the parts having first been freed from hair. Strips of this nature, however, are hard to remove, and do not adjust themselves to a decrease in the inflammation, and consequently are not advisable. The Horand-Langlebert suspensory is an elastic suspensory bandage devised to accomplish this purpose, and is useful in some instances. The best means, however, of effecting even and continuous pressure consists in the use of a light elastic rubber bandage about 1½ inches wide. The testicle requiring pressure is bandaged with the elastic in much the same manner as a bandage is applied to the end of a finger. One or two circular turns are first made around the testicle high enough up, so that the band cannot slip off. Then several turns are made forward and back at right angles to the circular turns, thus covering in the lower apex of the testicle. After the apex has been covered in this manner, then a few circular turns are given in order to hold in place the turns over the apex. Such a bandage should be put on lightly and should be readjusted every four to eight hours. While the rubber bandage is in use the testicles should be supported in order that there may be no drag on the cord.

Sometimes resolution from an attack of acute epididymitis is very slow. In such cases, although the pain, and in great measure also the tenderness, disappear, still the mass of inflammation largely remains. Such a condition of affairs may indicate that a tubercular element has grafted itself on to the original inflammatory process. Generally, however, it indicates the existence of inflammation in the cord, in the seminal vesicle, or in both these parts. Such a persistence of the inflammatory evidences is almost always seen in cases of epididymitis, in the treatment of which proper attention has not been paid to supporting the testicle, thus relieving the inflamed cord from tension. If one feels the cord in such instances, it is generally found to be brawny and approaching in circumference the little finger. The treatment of such a condition is of course careful support of the testicle. Iodide of potash in 5- to

10-grain doses three times a day may act as an internal aid in hurrying absorption in some cases. If seminal vesiculitis exists, that condition should be cured before complete resolution in the testicle may be expected. After gonorrheal epididymitis an obliteration of the efferent seminal ducts generally occurs in spite of the most careful treatment. Therefore if both testicles have been affected, the semen of the individual so attacked is commonly sterile.

Tubercular Epididymitis.—Formerly, when it was erroneously supposed that this affection commonly represented a primary focus of tubercular infection, prompt removal of the epididymis, together with the testicle and as much as was possible of the cord, found many strong advocates. Such treatment, however, is bad, as a more intimate knowledge of the pathology shows, unless it be possibly in a stray case where the disease might be primary. The treatment of this condition should be conservative as long as no suppuration or no active suppuration be present. It should be considered as a part of a more general process. The testicle should be supported, and should, if tender, be guarded against traumatism by being packed in wool. General hygienic measures, such as are useful in combating tubercular tendencies, should be prescribed. Cod-liver oil, if well borne by the digestive organs, is always of value. So also oftentimes are malt preparations, malt liquors, hypophosphites, etc. If suppuration becomes active, resulting in burrowing abscesses, external incisions should be made, glycerin, in which iodoform is thickly suspended (iodoform ʒij, glycerin ℥j) shoud be daily injected, and drainage-tubes, if necessary, inserted. If, in spite of such treatment, the suppurative process does not abate, then a free scrotal incision should be made and the diseased epididymis removed, together with the distal portion of the cord should that part be thickened. The surrounding pus-cavities should be opened and curetted, and, should the pyogenic membrane constituting their walls be thick, it should be snipped off by the aid of curved scissors. The body of the testicle itself, thus freed from inflammatory products, will in all probability be found to be natural in size and consistency, and should be left unmolested. Drainage should be established, and the cavity of the wound carefully irrigated with mild antiseptics till healing takes place. If the healing is tardy, iodoform and glycerin injections will often be found useful. An operation of this nature is not so severe as complete removal of the testicle. The patient is commonly up and about wearing a support at the end of five days. The testicle is generally left well nourished, and after healing has taken place there is little in appearances to indicate that an operation has been performed. The fact that removal of the epididymis only is an operation which confines the patient in bed a less time than complete removal of the organ is perhaps the strongest argument in favor of this procedure, since confinement in bed is always to be avoided as much as possible in tubercular cases. Then also the surgical procedure, other things being equal, which accomplishes its result with the least mutilation is the one to be chosen. Bennett was the first or one of the first to call attention to the fact that removal of the cord produced no visible effect on the testicle.

Syphilitic epididymitis should, when occurring as a late lesion, be treated the same as chronic specific orchitis, and should end in resolution. The epididymitis occurring in secondary syphilis is a transient lesion, and needs no special treatment aside from that generally employed in secondary syphilis.

Acute Seminal Vesiculitis.—Rest in bed, the patient lying flat on his back, is a most important requisite in the treatment of this condition. The testicles also should be supported the same as in acute epididymitis. This should be done even in cases in which the epididymis is not inflamed.

Sometimes, where the conditions are very acute, the foot of the bed may be raised in order to minimize the vesicular pressure. Poultices should be applied over the tender suprapubic area. These should be of liberal size, so as to extend considerably beyond the limits of tenderness. Where the tenderness is so great that the weight of the poultice cannot be endured, as may be the case if localized peritonitis exists, then some light substance like spongeopyline can be substituted. Opiates should be administered in sufficient amount to rid the pain of its paroxysmal character and make it easily bearable. Careful attention should be paid to the bowels. The rectum should be kept free from fecal accumulations. This can be accomplished by light laxatives aided in most cases by enemata. The enemata should be given after the laxatives have affected the upper bowel. To give these a long soft-rubber tube should be employed. This should be well greased and worked up slowly beyond the sigmoid flexure. Hot water should then be injected until the patient feels considerable distention. In some cases, where the bowel is very sluggish, salt may be added to the hot water in sufficient quantity to make it very brackish. After the pus begins to discharge itself freely through the ejaculatory duct, then the anodyne and poultices can be omitted. Sometimes resolution can be hastened after the sac has begun to discharge itself by the administration of iodide of potash in gr. v to gr. x doses two or three times a day. If while the pus is discharging urethral and vesical symptoms become annoying, balsamics may be given. Neither urethral injection nor urethral instrumentation is allowable. The inflamed vesicle also should not be stripped or manipulated by the finger in the rectum. The finger should be inserted into the rectum only occasionally in order to note the state of the inflammatory process. The patient should remain in bed till resolution has taken place in the vesicle. This generally takes about a month. By adopting this method of treatment resolution generally takes place if the patient is not strumous. In case, however, suppuration should occur outside the vesicle, resulting in abscess-formation, then a perineal incision should be made after the manner advocated by Zuckerkandl and drainage established.

Subacute and chronic seminal vesiculitis should be treated by the author's method of stripping the diseased sacs at intervals of five days or a week. A more detailed account of this process than is here necessary has been given in the author's book, reference to which has already been made. The technique to be observed in the performance of this treatment has already been described in considering the clinical features of the disease. Although from the description it may seem to be an easy matter to strip a diseased vesicle, still, in the author's experience, comparatively few can do it well without considerable practice, and some seem incapable of being taught to do it efficaciously. Among the usual causes for failure in practising this treatment are—inability to reach or locate the vesicles, a false conception regarding the aim of the treatment, and an improper application of force with the finger-tip. In some instances the finger of the surgeon may be too short, but in most cases a failure to reach the vesicle is due to the resistance offered by the perineal muscles. To overcome this resistance firm pressure should be made with the closed fist minus the extended fore finger. In this connection it may be well to quote briefly from an article by the author in the *Journal of Cutaneous and Genito-urinary Diseases*, June, 1894:

"In some thick-set, rigid individuals the perineal pressure required may be very considerable, since in such instances counter-pressure on the hypogastrium with the other hand accomplishes but little. In such cases the muscular effort required to enable the fore finger to perform the necessary stripping may be greater than an operator who is not physically fairly robust can command. As an aid in making perineal pressure where much resistance is encountered I have found that the knee corresponding to the arm used in manipulating can be made to play an important auxiliary rôle in pushing against the elbow. In order to carry out this maneuver a chair is drawn up behind the patient as he stands with his body bent forward in what I have been accustomed to term the 'leap-frog' position, and ready for the treatment. Then the foot of the operator corresponding to the hand to be aided is placed in the chair, thus bringing the knee up to the level of the elbow. By this arrangement the muscles of the thigh and leg, as well as of the arm and shoulder, all working together, can furnish pressure sufficient to overcome the resistance of the most rigid perineum. It is only occasionally that such extensive muscular efforts are called for. In weakly, loose-fibered individuals little or no perineal pressure is required to reach the vesicles, or even, if need be, much farther. In fact, in such cases with a little counter-abdominal pressure one can easily engage the tip of the fore finger in the sigmoid flexure."

Inability to locate the vesicles must be overcome by practice, and needs no further consideration here. The chief false conception regarding the aim of the treatment seems to be in confounding it with so-called "prostatic massage." In fact, some seem inclined to consider seminal vesiculitis a new term for prostatitis. A correction of this misconception, however, will come with a better general knowledge of the anatomy and physiology of the parts.

Then, again, many fail in stripping by exerting too little pressure with the finger-tip; a few, by exerting too much. It is a safe rule always to begin gently with a new case, where the parts are usually very tender, and to strive at first to get the patient accustomed to the manipulation before regular and complete strippings are attempted. If the stripping treatment is accomplishing the desired results, the parts should get gradually less and less tender, besides becoming more and more normal to the feel, and at the same time the subjective symptoms should show gradual improvement. When the treatment has been employed too vigorously or too often, then the finger will detect evidences of fresh engorgement; there will be a reappearance of tenderness, together with, oftentimes, an augmentation of subjective symptoms. The urine passed after the stripping will show the material expressed to be of increased purulency in purulent cases or to have become purulent in cases formerly non-purulent. Blood in greater or less amount may appear in the expressed material. Epididymitis may also result from an extension of the inflammation. In such conditions the treatment should be suspended till all the evidences of acuteness have disappeared. When this is done it will often be found that the parts are left better than before the over-treatment.

The duration of the treatment may be for a few weeks or months to a year or over. In simple non-gonorrheal cases in youthful subjects, where the vesicular walls are atonic and no perivesicular inflammation exists, the cure is generally prompt, while in cases where the sac is bound down by extensive perivesicular inflammation or the individual is advanced in years the relief from subjective symptoms may be slow, and a positive cure of the pathological process can never be said to occur. Still, even in the worst cases time and attention will generally suffice to rid the patient of all local distress and inconvenience. During the active stage of treatment coitus should not be practised, and everything tending to produce sexual excitement should be avoided.

The stripping process effects a cure in seminal vesiculitis by aiding and strengthening the mechanism of ejaculation and by promoting a reabsorption of inflammatory exudates. In all forms of seminal vesiculitis the mechanism of ejaculation is impaired, and in some instances it is rendered wholly ineffective. The stripping process in large measure accomplishes the results of ejaculation, while the muscles concerned in the act remain passive, and it does in many instances what the weakened mechanism has been unable to do —that is, it expels the jellified pathological fluid from the sac. The muscular apparatus by the passive exercise recovers its tone: it becomes better nourished, and the inflammatory adhesions which may have bound it down grow elastic and disappear.

During the local treatment the patient should live well. He should take regular exercise, although of course such exercises as horseback-riding and bicycling are to be excepted as too severe, unless he is robust, and especially if there be inflammatory exudates to be reabsorbed. Cod-liver oil, malt preparations, and other blood-producers are often of value. In very chronic cases, where the progress toward recovery is slow, an entire rest from treatment for a month or so at a time is often of benefit.

Tubercular seminal vesiculitis should be treated largely by hygienic measures. Occasionally a very gentle stripping may be beneficial. Such treatment, however, is generally injurious, as it tends to stir up and intensify the tubercular process. In fact, the manner in which a tubercular seminal vesiculitis resents the stripping treatment can often be used as evidence in making a differential diagnosis.

Extirpation of the seminal vesicle has been practised on a number of occasions, generally for tubercular conditions. The results from such operations, however, have not so far been very brilliant. Occasionally, however, the operation may be required. The Zuckerkandl, the Von Dittel, and the Rydygier incisions, or combinations of these, represent the surgical methods to be employed.

GROWTHS IN CONNECTION WITH THE TESTICLE AND SEMINAL VESICLE.

Dermoid Cysts.—The testicle is the favorite seat of dermoid cysts in men, as is the ovary in women. These formations, however, are less frequent in the testicle than in the ovary. They are probably congenital, though oftentimes they remain quiescent in youth, not growing enough to attract attention until adult life. They may contain cartilage, teeth, bone, hair, etc. They may be situated in the central portion of the testicle or may be attached to its periphery. Oftentimes they cannot be differentiated from spermatocele or encysted hydrocele until incised. They occasion no subjective symptoms, unless they become inflamed, other than may result from their size. For treatment they should be removed, since occasionally they degenerate, becoming the starting-point for malignant disease. Occasionally, when such growths originate in the periphery of the testicle, the sac can be dissected off without sacrificing the testicle. In most cases, however, the testicle has to be removed with the cyst.

Cancer of the testicle is not rare. It generally occurs in young or middle life. It usually exists in the form of medullary carcinoma, although rarely it may be scirrhous. It generally originates in the body of the testicle, although at times the epididymis is its starting-point. When the growth is soft and succulent, its usual variety, it progresses very rapidly, especially if its victim be young or robust. It soon extends beyond the confines of the capsule of the testicle, invading the loose connective tissue round about and also the scrotum. The cord itself is often involved. The scrotum when involved becomes brawny and adherent to the mass within it. Its veins also stand out prominently. Pain in the testicle itself is sometimes wanting, while at other times it is prominent and severe. As the disease advances the deep pelvic chain of lymphatic glands becomes involved, giving rise to much pain. Later on also, after the disease has extended beyond the testicle, the inguinal glands may become affected. The disease in its earlier stages may be accompanied by hydrocele. It may also be more or less cystic. Its tissues may break down, forming local sloughs. Such spots appear through the scrotum as soft and fluctuating. They may eventually discharge themselves, leaving putrid sinuses from which fungous masses may project. Sometimes cancer of the testicle may attain the size of a head. The only treatment for cancer of the testicle is early removal. After cancer has developed to any marked extent its malignant nature can easily be recognized. At first, however, its appearance may be simulated by late syphilis of the part and rarely by tubercle or cystic disease. When a case is encountered wherein cancer of the testicle is suspected in one who has never had syphilis, immediate extirpation of the testicle, together with the cord, should be prac-

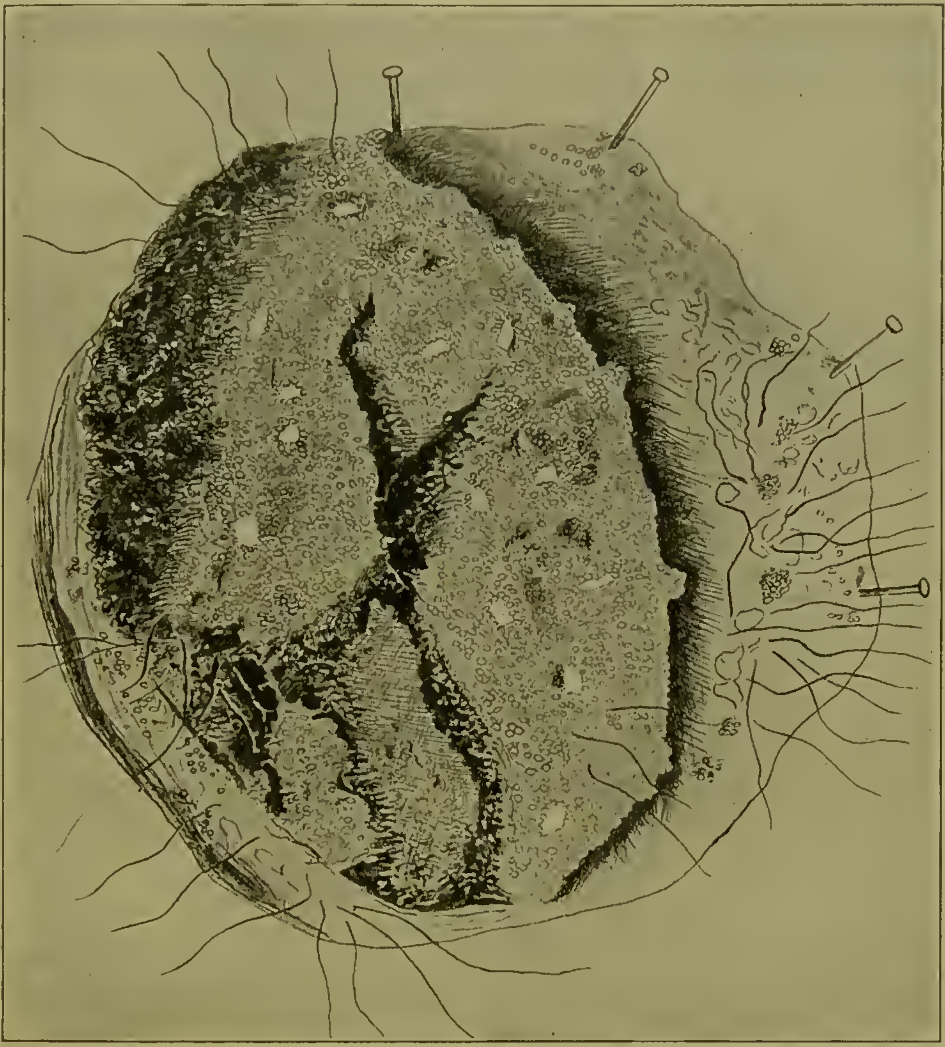

FIG. 67.—Dermoid cyst of the testicle (Reclus).

tised. If there is a strong suspicion that the disease may be syphilis, vigorous mixed treatment should be employed. Then, if after a week or so there has not been a change for the better in the testicle, that organ should be cut down upon and extirpated, except in case the close inspection which the scrotal incision has allowed has enabled the operator to decide that the affection is non-malignant.

Sarcoma of the testicle is also not rare. It occurs much as cancer does, and especially in the young and middle-aged. In most respects the description just given of cancerous affections applies also to sarcomatous ones, since a differential diagnosis between the two can rarely be positively arrived at without the aid of the histologist. Pain is apt to be a less prominent feature in connection with sarcoma than with cancer. Sarcoma also does not tend to involve the cord secondarily. It is more apt to grow as a compact mass, with a well-developed periphery, and to be free from outstanding nodules. The same treatment and the same remarks regarding when to operate in suspicious cases which were made with reference to cancer apply equally to sarcoma.

Enchondroma and **adenoma of the testicle** have been observed. Such growths, however, should always be regarded as suspicious, since the real line which separates them from malignant disease is often indistinct if not imaginative. Taylor has recently reported, as representative of mixed malignant disease of the testicle, a case which the histologist has pronounced to be a combination of sarcoma, cystic adenoma, and carcinoma. It is probable that some growths do not start histologically malignant, but rapidly become so, and Taylor's case may represent one of them in the stage of histological transition. These ill-defined growths should receive the same surgical attention as cancer or sarcoma.

Malignant Disease of the Seminal Vesicle.—It is not uncommon for cancerous affections of adjacent or connecting organs to extend to and involve the seminal vesicle. In such instances the cancer may be primary in the prostate, bladder, rectum, or testicle. Primary cancer of the seminal vesicle, however, is apparently quite rare, although, were digital rectal exploration of these organs more commonly and systematically practised, it probably would be found to be of much more frequent occurrence than the present statistics indicate. Guelliot, who has analyzed 14 cases in which one or both seminal vesicles have been affected by cancer, finds but 1 in which the growth was distinctly primary in the seminal vesicle. Gay reports a case of primary cancer of the seminal vesicle in which he made an unsuccessful attempt to eradicate the disease by extirpating the organ, an incision apparently similar to that of von Dittel being employed.

Sarcoma of the seminal vesicle, either primary or secondary, is of very rare occurrence. Zahn reports the only case of primary sarcoma of this organ.

Malignant growths of this part, if at all extensive, interfere with urine drainage, and to a less extent with the functions of the lower bowel and rectum. They are also accompanied by pain more or less localized. The recital of clinical symptoms, however, has been so meager in the few cases reported that an attempt at detail in this particular is impossible. Where disease is confined to the seminal vesicle speedy extirpation of the organ is advisable. Rydygier's incision, which is a modification of Kraske's, is the method which should be employed, since that cut gives the operator the space necessary to make the removal most thorough and complete.

DISEASES OF THE PROSTATE.

By J. WILLIAM WHITE, M.D., and ALFRED C. WOOD, M.D.

Definition.—Greek, *prostatēs*, one in the front rank, from *πρό*, *pro*, before, and *ἵστημι*, *histēmi*, stand, place.

Synonyms.—*Lat.* Prostata; *Ger.* Vorsteherdrüse, Prostata; *French*, Prostate.

Development.—The prostate gland can be recognized during the fourth (Kölliker) or fifth month (Mihalkovics) of fetal life as a series of branching evaginations of the epithelium of the upper extremity of the urogenital sinus. The evaginations later extend into wide, irregular cavities. The muscular tissue of the prostate is developed much later from the mesenchyma of the walls of the sinus. According to Tourneux, the evaginations persist in the female in a more or less rudimentary condition.[1]

The question of the analogy between the prostate gland and the uterus has been frequently raised. It is now believed, however, that the analogue of the uterus in the male is the prostatic vesicle, or sinus pocularis. The united portion of the Müllerian ducts later forms the foundation of the prostatic vesicle, or uterus masculinus, in the male, and of the vagina and uterus in the female. The upper or fore part of the Müllerian duct disappears in the male; in the female it forms the oviduct (Fallopian tube). The hydatids of Morgagni are believed to represent in the male the remnant of part of the Müllerian duct. In certain animals the prostatic vesicle of the male is prolonged into cornua and tubes resembling the uterus in the female.[2]

The large number of dissections made by Thompson, Charles Bell, Gross, Deschamps, Messer, and others have shown that the prostate is relatively very small in childhood, and that it grows but little until the age of puberty. At this period there are a rapid development of the glandular elements of the organ and a coincident increase in its size (Socin).

Anatomy.—**Description.**—It is customary to describe the prostate gland as though it were a distinctly defined organ with clearly outlined borders, whereas it is so intimately connected with the bladder and urethra that its limitations are difficult to determine. This fact led some of the older authors to deny that the prostate was a separate organ, and as such deserving of a special name and description. More recent studies have resulted in a better understanding of its functions in health and disease, and have shown its importance as an accessory sexual organ.

With this explanation the usual description of the prostate—that in the adult man it is about the size and shape of a horse-chestnut (the fruit of *Æsculus Hippocastanum*)—will answer, perhaps, better than any other. The exact size is very difficult to determine, for the reason already given. It is only the surface facing the rectum that is accessible to examination during life. The introduction of a metal bougie into the urethra during the digital rectal examination materially assists in estimating the approximate size of the gland.

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[1] Minot, *Human Embryology*.

[2] Quain, *Human Anatomy*.

Sabatier[1] described the following layers of the prostate: 1, mucous membrane; 2, longitudinal fibers; 3, deep circular fibers connected with the canal of the urethra and continuous with the circular layer of the bladder; 4, longitudinal fibers which are the terminations of the oval fibers of the bladder; 5, a very thick layer of circular superficial fibers which comprise almost the whole mass of the prostate: these fibers are eccentric to the deep circular fibers surrounding the canal of the urethra, and contain the glandular substance; 6, the capsule, composed of fibrous tissue which serves as a covering for the gland and as a tendon of insertion for some of the fibers of the bladder.

Pettigrew[2] says the fibers of the bladder and prostate with few exceptions form figure-of-eight loops. They are arranged in layers which may be divided into three sets of internal loops and three sets of external loops, with an intermediate or central set; the anterior and posterior fibers of the latter, according to Pettigrew, largely form the sphincter vesicæ. He also found that the fibers of the urethra are continuous with and drag on the median ridge (verumontanum); the ureters, acting together, tend to elevate the median ridge during contraction. The shape of the verumontanum is that of an inverted pyramid, the base of which is turned toward the base of the prostate. Its narrow end is consequently directed downward and forward; it is attached by one side of the pyramid to the prostatic urethra, the two sides that are free terminating in a well-defined crest. The prostatic portion of the urethra is triangular, and fitted so closely to the verumontanum that urine cannot be made to escape even in the dead subject without considerable pressure; it is therefore easy to perceive that in the living individual, when the parts are injected with blood, the obliteration must be very complete. In addition, the urine by its own weight acting upon the base of the wedge-shaped verumontanum would tend to make the closure more secure. When the bladder contracts the longitudinal fibers which connect the verumontanum with the ureters where they meet in the middle line have the effect of elevating or withdrawing the wedge, and thus assist in rendering the orifice of

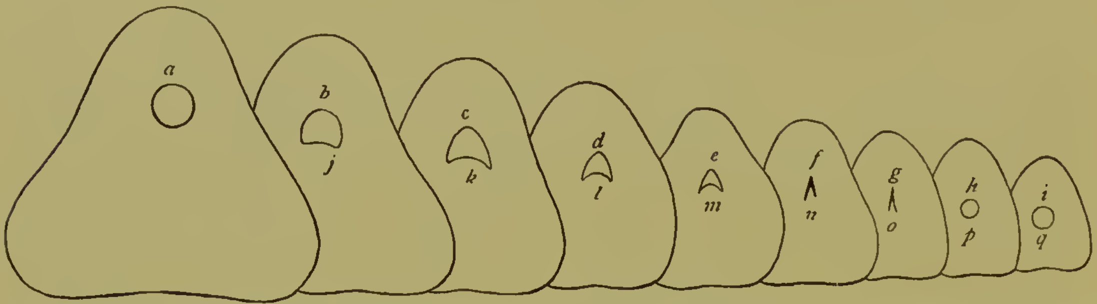

FIG. 68.—Diagrammatic sketches of transverse sections of prostate and urethra, showing the precise shape and degree of obliquity in the urethral canal at different points, and the part which the verumontanum plays in the closure of it (Pettigrew): *a*, urethra at base of prostate, oval in shape, and quite open; *b*, urethra a little further forward, oval, floor (*j*) slightly elevated; *c*, urethra somewhat triangular in shape, the verumontanum (*k*) beginning to project from the floor or base of the triangle; *d* and *e*, urethra more decidedly triangular, the verumontanum (*l* and *m*) projecting to such an extent as almost to obliterate the urethral canal; *f* and *g*, urethra bayonet-shaped and entirely closed by the projection of the verumontanum (*n*, *o*), which acts at this point as a mechanical wedge; *h*, *i*, *p*, *q*, urethra circular in form and again becoming patent.

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[1] *Traité d'Anat.*, Paris, 1777.

[2] "On the Muscular Arrangement of the Bladder and Prostate, and the Manner in which the Urethra and Ureters are Closed," *Phila. Trans.*, part 1, 1867.

the urethra patent. Sabatier speaks of the verumontanum as the "gate-keeper" of the prostatic portion of the urethra.

Ellis[1] thinks the point where exquisite sensitiveness is experienced in passing a catheter, as the instrument approaches the neck of the bladder, is the verumontanum, and not the trigone. As pointed out by Guthrie,[2] in the normal bladder, when but moderately distended, even the triangular space is below the level of a catheter introduced through the urethra.

The closure of the urethra is favored by the contraction of the very oblique or circular fibers forming the urethra, and by the prominence of the uvula vesicæ (lutte vesicale) and median ridge in the female and by the caput gallinaginis or verumontanum in the male. The urethra from the disposition of the fibers should be considered as the proper continuation of the bladder anteriorly. The longitudinal fibers of the prostate and urethra are separated by a considerable interval, and the very oblique or circular fibers, which are widely distinct and have separate axes at the cervix where the sphincter is most fully developed, curve into and are blended with each other in the region of the verumontanum. This is important as showing how the sphincter may act independently of the prostate, and the reverse.

Measurements.—The following are the average measurements of the prostate: from base to apex, $1\frac{1}{4}$ to $1\frac{1}{2}$ inches (31 to 38 mm.); greatest transverse diameter, about $1\frac{3}{4}$ inches (44 mm.); greatest thickness, about $\frac{5}{8}$ to $\frac{7}{8}$ inches (16 to 22 mm.). These figures agree with those given by Deschamps, Gross, and Hodgson, but are less than those given by Dupuytren, which are—transverse diameter, $1\frac{2}{3}$ to 2 inches (42 to 50 mm.); thickness, $\frac{5}{6}$ to 1 inch (22 to 25 mm.). The former figures more closely approximate the true dimensions.

Weight.—The exact weight of the prostate is a matter about which it is difficult to make a definite statement. The difficulty of separating the gland accurately from surrounding structures, already alluded to, explains the lack of harmony existing between the figures given by different writers. It may be said, however, that from 4 to 6 drams (16 to 24 grams) represent the usual weight of the normal adult gland. The average weight in specimens dissected by Thompson was 4 drams and 38 grains (18 grams). Messer's figures correspond very closely with this—4 drams and 57 grains (19 grams).

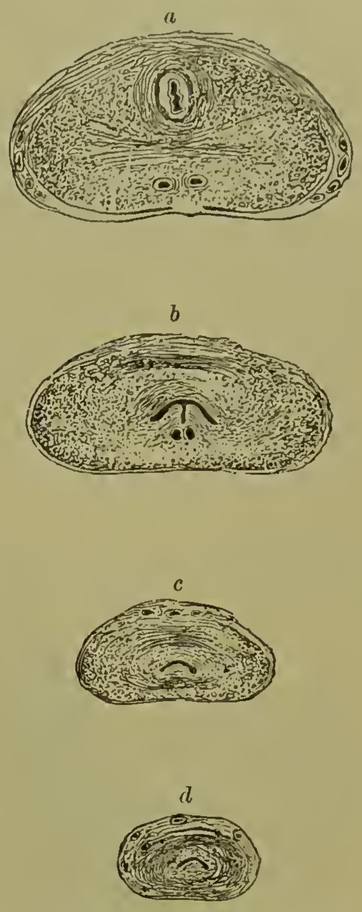

FIG. 69.—Cross-sections of the prostate, perpendicular to the urethra (Henle): *a*, near base; *d*, near apex; *b* and *c*, intermediate sections.

Anatomical Relations.—The prostate surrounds the vesical end of the urethra, and is placed immediately in front of the bladder. It lies between two imaginary lines, both of which begin at the tip of the coccyx, one going to the upper border and one to the lower border of the symphysis pubis. The base is 20 mm. and the apex 10 mm. from the posterior surface of the symphysis (Kohlrausch). In the vertical position of the body with moderate inclination of the pelvis the prostate is vertical, the base being directed upward and the apex downward. The *facies pubica* (Mercier) is concave from side to side, is directed toward the anterior wall of the pelvis, and is attached to the symphysis by the pubo-prostatic ligament. The posterior surface, *facies rectalis* (Mercier), is more flat, and is connected with the anterior wall of the rectum by firm connective tissue which is devoid of fat. The lateral borders are convex; they stand out prominently, and are covered by the anterior portions of the levator ani muscles. The base or upper surface, *facies vesicalis* (Mercier) presents a depression in the middle. The apex, *facies urethralis* (Mercier), rests on the urogenital diaphragm (Henle). The gland is pierced by the urethra, which in this situation is designated the prostatic portion. In the upright position of the body the prostatic urethra describes an arc, the convexity of which is posterior, and the chord of which is nearly vertical.

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[1] "An Account of the Urinary and Certain of the Generative Organs of the Human Body," *Med.-Chir. Trans.*, vol. xxxix.

[2] *On the Anatomy and Diseases of the Urinary and Sexual Organs*, Lond., 1843, p. 6.

17

The prostate surrounds, besides the urethra, the lower end of the spermatic ducts and the so-called prostatic vesicle. The ejaculatory ducts enter

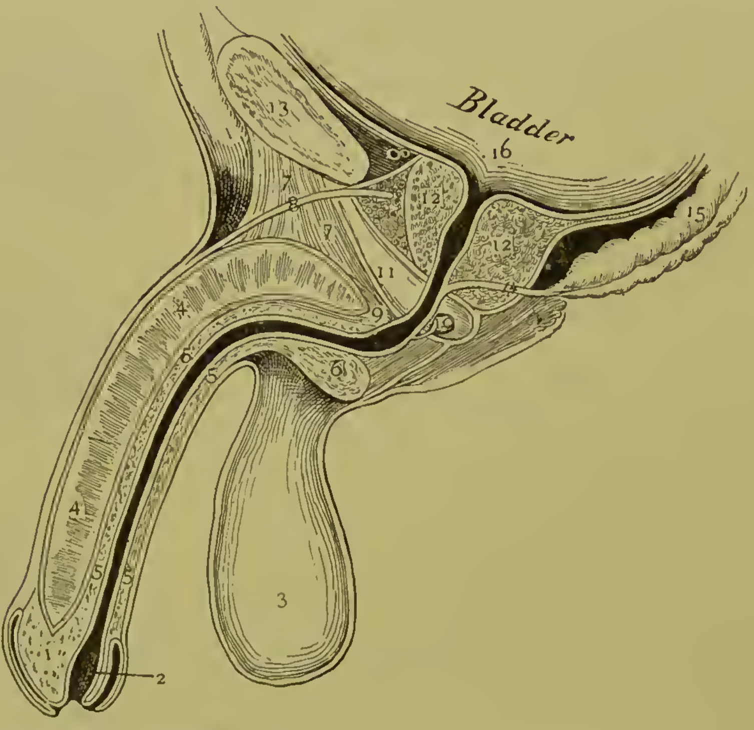

FIG. 70.—Vertical section of bladder, prostate, urethra, etc.: 1, glans penis; 2, fossa navicularis; 3, scrotum; 4, corpus cavernosum; 5, corpus spongiosum; 6, bulb; 7, suspensory ligament; 8, dorsal vein of penis; 9, crus penis; 10, Cowper's gland; 11, space between the two layers of the triangular ligament: the portion of urethra included in this space is designated "membranous," and is fixed; 12, prostate gland; 13, pubis; 14, ejaculatory duct; 15, seminal vesicle; 16, neck of bladder. The cut is, of course, diagrammatic. The urethra is represented as an open tube instead of as a collapsed canal, which it really is.

from above in the base of the prostate near its posterior surface, where they are 6 to 8 mm. distant from the urethra. In the prostate they are diverted a little toward the front and pass to the sides of the colliculus seminalis, opening into the urethra with slit-like openings. At their entrance into the prostate they are from 3 to 4 mm. distant from each other, while their openings in the urethra are separated only by the sinus pocularis, in the walls of which they run.

In the median line of the prostate the position of the urethra is represented by a furrow, more readily felt than seen, which divides the body of the gland into two lateral halves, while the ejaculatory ducts in their course, already described, form the so-called "third lobe," which by many writers is said to exist pathologically only. This median portion has been erroneously described as lying between and behind the entrance of the ejaculatory ducts, whereas it is really in front of them. Cruveilhier considers the "middle lobe" abnormal, but admits a median portion which Mercier calls "*portion susmontanale*." Thompson, after examining a large number of healthy prostates, does not accept the existence of the "third lobe" described by Home.

The deep perineal fascia, a portion of the pelvic fascia, descends from the posterior aspect of the pubic bones and adjacent ischia, closing in the pubic arch and investing the lower surface of the levatores ani. A prolongation of this fascia envelops the prostate and encloses the veins which pass on either side and in front of the gland. Numerous fasciculi pass inward to the proper capsule of the prostate. A continuation of the same fascia binds the seminal vesicles firmly to the base of the prostate and bladder.

The prostate is held in position in part by ligamentous and muscular attachments. The pubo-prostatic ligaments pass from the posterior aspect of each pubic bone at its lower border to the anterior surface of the prostate, and thence to the bladder, where they become continuous with the fibrous tissue surrounding the vesical neck. These ligaments consist of the recto-vesical portion of the pelvic fascia. A pair of muscles, one of which arises from an oblique line on the posterior surface of each pubic bone and joins its fellow, passes in front of and below the apex of the prostate, some of the fibers being continued along the lateral borders.

Histology.—Before the age of puberty the prostate is composed almost entirely of unstriped muscle, the glandular elements being inconspicuous. When full development has taken place the gland-tissue comprises from one-fourth to one-third of the volume of the organ, and is distributed mainly in its posterior and lateral portions (Kölliker). The portion of the gland lying in front of the urethra is said by Jarjavay, who has examined 100 specimens with this point in mind, to contain no glands. Luschka affirms the truth of this observation, to which, however, he claims there are occasional exceptions.

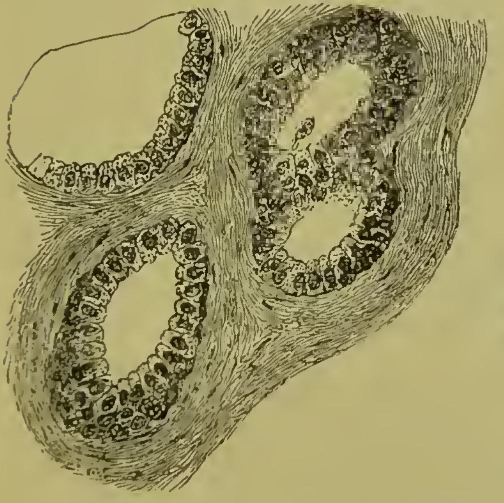

FIG. 71.—Prostate of a sixteen-year old youth (Socin).

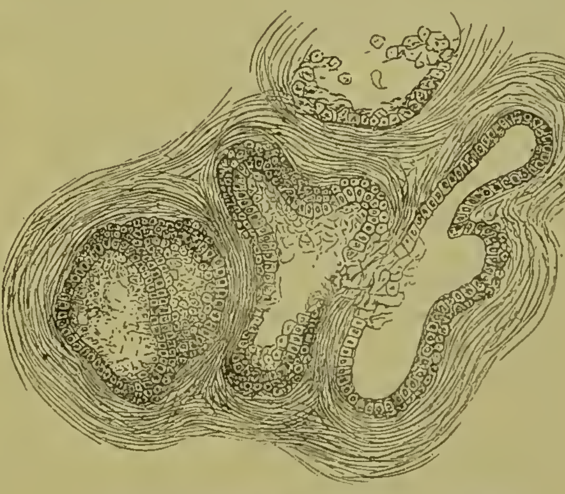

FIG. 72.—Prostate of an adult (Socin).

The prostate, on section, has a reddish-gray color and is of spongy consistence. Microscopically, it consists of numerous (according to Kölliker, thirty to fifty) branched tubular glands ending in blind extremities. Some doubt still exists as to whether the construction is acinous or tubular. Before puberty the tubules are narrow and there is a large amount of intermediate substance; after this period the glands expand and the intercellular substance diminishes. The prostate is covered by a capsule composed of muscular and connective tissue which is very adherent to the gland itself. Between this, which may be called the proper sheath of the prostate, and that before described is situated the prostatic plexus of veins, which is continuous with the dorsal veins of the penis. The muscular arrangement of the gland has already been described. The secretion of the prostate is acid.

Vessels and Nerves.—The blood-supply to the prostate is through the vesico-prostatic artery, a branch of the inferior vesical, which passes to the side of the prostate, and through small unnamed branches of the internal pudic and the middle hemorrhoidal branch of the inferior vesical arteries. In some cases the internal pudic artery is replaced by the accessory pudic. Quain describes the course of this vessel as follows: "In passing by the prostate and urethra—and it is here that the exact situation of this artery is of serious concern to the practical surgeon—the accessory pudic lies on the upper part of the gland, or it may be for a short space likewise on the posterior margin, and then, proceeding forward above the membranous part of the urethra, it reaches the perineum and divides into its terminal branches."

The veins of the prostate, which are known as the prostatic plexus, are formed mainly by the breaking up of the divisions of the dorsal veins of the penis, but they receive also smaller branches from the gland and from the neighboring muscles. The plexus surrounds the base of the prostate, being distributed most thickly on its anterior and lateral aspects, and communicates below with the tributaries of the pudic vein, while above it is continuous with the vesical plexus. In old persons these veins are generally much dilated and their valves become imperfect or even disappear.

The lymphatics of the prostate ascend to glands below the external iliac vessels.

The nerves of the prostatic plexus are of considerable size, and pass between the prostate gland and levator ani muscles. Some of the fibres pass to the prostate and to the seminal vesicles. The plexus is continued forward to supply the erectile tissue of the penis, where it receives the name "cavernous." The secretory fibers of the prostate come from the sacral sympathetic. The sensory nerves, according to Head, are derived from the tenth, eleventh, and twelfth dorsal, the first, second, and third sacral, and the five lumbar.

Malformations and Anomalies of the Prostate.—Entire absence of the prostate is found only in cases of extensive defects of the genital and urinary organs and pelvis. The formation of cloacæ and split bladder does not interfere with the development of the prostate and seminal vesicles.

Injuries of the Prostate.—Wounds of the prostate are rare by reason of its situation. It is possible to conceive of a blow on the perineum sufficiently violent to affect the prostate, but such an accident must be of great rarity. Blows on the perineum from a sharp body may easily involve the prostate, and it may be also wounded in cases of extensive fracture of the pelvic bones. The gland may also be injured by the trocar in the act of puncturing the bladder by either the perineal or rectal method, a procedure now rarely employed, by the introduction of foreign bodies into the rectum, and by clumsy attempts at passing urethral instruments. Wounds of the prostate are unavoidably inflicted during perineal lithotomy.

The **symptoms** of these injuries will depend upon the cause and the situation of the wound. The dangers are—1, if the urethra be involved, urinary infiltration; 2, hemorrhage; 3, infectious phlebitis. The extravasation of urine from a wound of the prostate may be in the direction of the perineum, in which case the ischio-rectal spaces will be involved, or it may be directed upward into the prevesical space, from whence it may spread rapidly through the areolar tissue of the abdomen, thighs, penis, and scrotum. In either case the tissues will be edematous and boggy, and either of a bright-red or livid hue. In wounds confined to the prostate the extravasation is usually restricted to the prevesical space by the layers of the recto-vesical fascia.

Hemorrhage may be slight in amount or very profuse; in the latter case a globular tumor is apt to form above the pubes. If the vesical neck be divided, the blood may flow backward into the bladder.

Infectious phlebitis causes an infiltration and induration of the coats of the prostatic plexus of veins. The vessels are hard and cord-like, the gland is very tender to the touch, and the fibrinous and serous exudations completely destroy its elasticity. The condition is rapidly followed by chills, fever, quick pulse, dry, coated tongue, nausea and perhaps vomiting, and sometimes by delirium. In other words, the typhoid condition is not uncommonly present. When suppuration occurs there is danger of serious hemorrhage from the breaking down of the walls of the veins.

Wounds of the prostate produced by forced catheterization for the relief of urinary retention due to enlargement of the prostate have not infrequently been followed by serious or fatal consequences. The practice should be unreservedly condemned, as the extent of the injury and the consequences must remain unknown the operator.

Treatment.—In general, lithotomy and other wounds of the prostate made by the surgeon heal kindly, and are seldom followed by urinary fistula or obstruction of the urethra. A few cases are on record in which the contraction of the prostatic wound resulted in an interference with the action of the vesical sphincter and caused a more or less permanent condition of incontinence.

In the case of an external wound which does not involve the neck of the bladder the indications for treatment would be those common to all lacerated wounds—namely, the removal of foreign bodies, the thorough cleansing of the wound-surfaces, and the arrest of hemorrhage and drainage. Usually no ligatures will be required, the packing of the wound with iodoform gauze being sufficient to arrest any bleeding. A Nélaton catheter should be introduced into the bladder through the urethra and allowed to remain for a few days, as the inflammatory swelling which is apt to occur would probably cause retention and make the introduction of a catheter difficult at that time. If the vesical sphincter has been divided and there is evidence of hemorrhage into the bladder, a full-sized soft-rubber catheter should be passed through the urethra and the bladder thoroughly irrigated with warm boric acid solution. If it be impossible to introduce an instrument into the bladder, a perineal urethrotomy should be performed, and after washing out the bladder with the boric acid solution a catheter *en chemise* should be introduced. This will drain the bladder, and will facilitate the packing of the wound to control hemorrhage. A carefully applied tampon of iodoform gauze will always control hemorrhage in this situation.

The most careful asepsis in the treatment of these wounds is the only means we have by which to guard against the occurrence of infectious phlebitis. If this condition should supervene, it will be necessary to perform frequent antiseptic irrigations of the wound, to secure free drainage, and to support the patient by the administration of quinine, strychnine, and stimulants. Gentle catharsis should be induced, and if pain is severe anodynes may be required. Lead-water and laudanum may be applied to the perineum to relieve pain and congestion. In the cases in which the bladder becomes filled with blood, as in forced catheterism for retention of urine due to an enlarged prostate, a catheter should be introduced into the bladder and the blood withdrawn. The coagula may be disintegrated by the injection of sterilized tepid water or, preferably, boric acid solution. If the return-flow is arrested by fragments of clot, suction may be made by means of a syringe. If it has been impossible to break up the clot, weak solutions of pepsin, faintly acidulated, may be introduced into the bladder two or three times daily. Even if the presence of the clot in the bladder does not give rise to either distress or retention, it is desirable to carry out the same treatment in order to avoid the possibility of infection and consequent severe cystitis. In cases in which there has been a possibility of infection it is wiser to use a more powerful antiseptic than boric acid, and a solution of carbolic acid, 1 : 200 in a 1 : 5000 solution of bichloride of mercury, may be employed. In all these cases urinary antiseptics, such as boric acid or salol, should be administered internally: 10 grains of either may be given three or four times a day.

Foreign Bodies in the Prostate.—These are usually portions of catheters which have broken off of faulty instruments during their introduction or calculi that enter from the bladder. Cases are occasionally met with in which various bodies have been introduced into the urethra for erotic purposes, sometimes by old men under the influence of sexual aberration and the excitation which often accompanies the early stage of prostatic hypertrophy.

Such bodies, having been introduced beyond the reach of the fingers, have eventually lodged in the prostatic sinus. By inflammation and ulceration they may work their way into the substance of the gland.

Symptoms.—There are usually considerable vesical irritability, pain, and tenderness in the perineum and a constant desire to urinate. By rectal examination the gland will be found swollen and tender to the touch. If the inflammation has gone on to abscess-formation, fluctuation may be detected.

Treatment.—Sometimes these bodies may be removed through the urethra by means of appropriate forceps. This is especially true of small calculi that lodge in the prostatic urethra, and to a less degree of fragments of catheter. If the foreign body cannot be removed in this manner, it will be necessary to explore the gland through a median perineal incision. If suppuration is present, the abscess-cavity should be thoroughly curetted, irrigated, and drained either by means of rubber tubes or by packing with iodoform gauze.

Acute Prostatitis.—Two varieties of acute inflammation of the prostate are described: 1, that in which the inflammation affects chiefly the follicles, and 2, that in which the entire gland is involved, the parenchymatous variety.

Etiology.—Acute prostatitis as an independent and primary affection is rarely met with. Among the causes described are external influences, such as sudden exposure to cold or wet and blows on the perineum. In the vast majority of cases the inflammation of the prostate has been transferred from more exposed neighboring organs by continuity or has been developed in the course of one of the acute infectious diseases. The most common cause by far is acute urethritis. Occasionally a urinary calculus lodging in the prostatic sinus will excite inflammation. Olive observed acute prostatitis, followed by severe cystitis and prostatic abscess, in a case after the application of a large plaster of cantharides. Prostatitis is an infrequent sequel of acute febrile diseases, and cases have been reported in patients suffering from small-pox, scarlet fever, typhoid, typhus, etc. Prostatic abscess is not uncommonly met with in cases of pyemia. Occasionally patients suffering from bed-sores develop thrombosis of the prostatic plexus, which is followed by suppuration. Infection by contiguity—as from the rectum, for example—is very rare, doubtless owing to the firm capsule that envelops the gland. Next to the gonorrheal variety, those cases in which both infectious and traumatic factors enter are the most common. They follow the use of sounds or catheters that are not surgically clean, especially if some abrasion has been produced by their unskilful introduction. Tubercular prostatitis will be considered under a separate heading.

Among other causes which may be mentioned are—urethral stricture, which tends to produce inflammation of the parts posterior to it; the direct application of irritating agents, such as injections of strong chemicals, cauterization, etc.; horseback exercise, bicycle riding, drastic purgatives, etc. It does not appear at all established that either horseback exercise or bicycle riding under proper conditions predisposes to inflammation of the prostate. It is probable that this is a superstition promulgated by the laity chiefly, but somewhat heedlessly accepted by some in the profession.

Morbid Anatomy.—Opportunity is rarely afforded for examining the prostate in the condition of acute inflammation. Thompson has, however, examined such specimens and observed the following conditions: the gland was swollen to double or even quadruple its natural size, and felt tense and firm to the hand. The external blood-vessels were engorged with dark blood. On making an incision from the front aspect into the urethra the mucous membrane was seen to have a somewhat deeper tint than natural, although there was less change here than one might expect; the cut surface was redder than in health; pressure caused to exude a reddish, somewhat turbid fluid, a mixture of effused lymph and serum, of blood from loaded capillaries, of prostatic secretion, and a very small quantity of pus. The same fluids exuded, but in somewhat greater quantity, from sections through the lateral lobes. As the inflammation advanced the fluid contained a larger admixture of pus, and a section of the lateral lobes especially showed several minute spots of thickish pus—not abscesses, apparently, strictly speaking, but the gland-crypts, whose lining cells were then secreting pus and whose cavities were distended with it. As the morbid action continues these phenomena pass insensibly into others which indicate more permanent and organic changes in the organ, and which generally follow the preceding if resolution does not take place.

The changes that take place in the later stages are such as are common to inflammatory processes in general: the secretion of purulent matter and the organization of effused lymph lead to the formation of isolated deposits of pus or small abscesses in the substance of the prostate. These are found either numerous and small, or fewer and larger; the size of the abscesses varies from that of a grain of barley or a pea to that corresponding nearly to the entire gland. The larger abscesses result from the coalescing of the smaller deposits by the destruction of the intervening tissue. It is to be observed that the pus of a prostatic abscess has usually, if not always, a peculiar glutinous or adhesive quality, differing from the diffluent creamy character of ordinary healthy pus. Sometimes clots of blood are found, the result of small hemorrhages into the diseased gland-crypts or other cavities. Portions of the organ may soften and break down. The mucous membrane of the prostatic urethra is reddened, sometimes thick and velvety, or it has patches of whitish and membrane-like material closely adhering to the surface—exudations of organized lymph. Again, a portion of the mucous membrane may be destroyed by ulceration or gangrene, and give exit to a collection of pus. This is one of the ways in which a prostatic abscess evacuates itself spontaneously.

Symptoms.—The symptoms in both the follicular and parenchymatous varieties are very similar; in the latter they are rather more severe, and are more frequently followed by abscess. The follicular variety usually depends upon a pre-existing urethritis; the parenchymatous form is much more rarely due to this cause. The earliest symptom is a feeling of heat and weight in the region of the perineum and bladder. Severe pain is soon felt on micturition and on defecation. Urination becomes frequent and is attended with tenesmus in proportion to the degree of involvement of the neck of the bladder, or there may be retention from the swelling of the gland. The patient experiences an exacerbation of pain on motion, and sitting is uncomfortable or may be impossible. The perineum is found sensitive on pressure, and the introduction of the finger into the rectum causes a spasm of the sphincter which is irritated by the adjacent inflammation. The prostate is found to be enlarged, hard, hot, and very painful on pressure. In this class of cases there is always more or less fever, with the attending constitutional disturbance. If pus forms, there may be chills. Every degree of intensity is met with; in the milder varieties the symptoms are much less pronounced. Fluctuation may often be detected by rectal palpation after suppuration has occurred.

In the subacute cases there may be but few symptoms. Such a course may be observed in cases of pyemia. Socin found an abscess in the right lobe of the prostate as large as a pigeon's egg in a man who died of pyemia from a phlegmon of the right foot.

Usually an abscess of one lobe discharges spontaneously through the urethra. If, however, the intercellular substance is affected, the whole gland may break down rapidly, with the development of pronounced constitutional symptoms; a diffuse phlegmon is apt to occur if the periprostatic tissue becomes involved. These larger abscesses are apt to discharge into the rectum. If the pus is not evacuated, either naturally or by incision, it may ascend and penetrate the peritoneal cavity, causing a rapidly fatal septic peritonitis, or it may burrow subperitoneally, or, being guided by the levatores, may escape through the ischiatic foramen and appear on the buttock or thigh.

Usually on evacuation there are rapid shrinking and cicatrization of the abscess-cavity, ending in complete cure. In other cases septicemia or pyemia may cause a fatal termination. Occasionally long-standing fistulæ remain. The fistulæ may be urethro-rectal, prostato-rectal, or urethro-perineal, depending upon the direction in which the abscess ruptured spontaneously or was opened by the surgeon.

Diagnosis.—The diagnosis of acute prostatitis is ordinarily not attended with difficulty. In the presence of a specific urethritis, or, following one of the various causes mentioned, if the patient experiences a constant and deep-seated pain, throbbing in character, which may or may not be referred to the rectum, and if, in addition, there is frequent and painful micturition and acute pain is felt during defecation, it is more than probable that the prostate gland is the seat of acute inflammation. This will be confirmed if the gland is found to be enlarged and extremely tender on rectal examination. If there is retention of urine and it becomes necessary to introduce a catheter, extreme pain will be experienced as the instrument reaches the prostatic urethra.

Acute prostatitis must be differentiated from inflammation of the neck of the bladder (which to a certain extent probably always coexists). This will be done by remembering the much greater prominence of the urinary symptoms, and the absence of complaints connected with the perineum or rectum, in the vesical inflammation.

In the condition known as Cowperitis, which may give rise to symptoms more or less closely simulating those of prostatitis, there will be found a deep, circumscribed, very tender perineal tumor on one side of the middle line, and the rectal symptoms common to the last-named condition will be absent.

It will occasionally be necessary to distinguish between retention of urine from stricture and enlargement of the prostate from that due to prostatitis. If, however, the history be borne in mind and the usual urethral and rectal examinations be made, a mistake will not be apt to occur. As strictures of the prostatic urethra are unknown, obstruction from a urethral coarctation would be found anterior to this point.

In all of the conditions mentioned the rectal examination would be conclusive. The presence of a moderately enlarged, exquisitely tender prostate gland would be characteristic of inflammation. In hypertrophy of the gland, although there would be enlargement, there would be little tenderness on pressure. In addition to the symptoms mentioned in the inflammatory affections there would be more or less fever, depending upon the kind and degree of the inflammation.

Treatment.—The treatment of acute prostatitis, like that of other inflammatory processes, demands at the outset as nearly absolute rest as it is possible to secure. It is desirable, therefore, that the patient should go to bed and that the hips should be raised on pillows higher than the body. The treatment should be antiphlogistic, both local and general. A number of leeches may be applied to the perineum and around the margin of the anus at intervals of a few hours. Repeated short, hot sitz-baths (100° to 105° F.) act beneficially by causing an acute hyperemia of the skin, not only of the part included in the bath, but of the general surface of the body, which relieves to a marked degree the congestion of the internal parts. If there is pronounced vesical irritation, a mixture containing sodium bromide, boric acid, and belladonna will be found to give great relief. If there is much fever, a diaphoretic mixture containing moderate doses of potassium citrate, sweet spirit of nitre, and aconite will be beneficial. If the pain is severe, a small quantity of morphine may be added to this mixture or opium may be given in suppositories. The use of hot-water clysters will also be beneficial. Saline or other laxatives should be given regularly. The patient should be cautioned against straining either during micturition or defecation. If there is retention, the urine should be drawn at proper intervals with a Nélaton catheter (14 to 16 of the French scale).

During the acute stage of the attack the diet should consist largely of milk; alcoholic and other stimulants should be interdicted; water should be taken freely.

If the case should go on to suppuration, the symptoms will be found to ameliorate considerably, and fluctuation may be detected by digital, rectal examination. (See Abscess of the Prostate.)

A fistula may persist for some time, but usually closes spontaneously. If during convalescence the patient attempts to get about too soon, a relapse may be caused and the course of the disease much prolonged.

Periprostatitis and Periprostatic Abscess.—Suppurative prostatitis may extend to the cellular spaces between the rectum and the prostate or the deep perineal spaces, giving rise to periprostatic abscesses, which are usually caused by infection through the lymphatics from the deep urethra or through a phlebitis of the prostatic plexus.

The symptoms of these abscesses (both prostatic and periprostatic) are alike: there may be retention of urine, and swelling and fluctuation are always detected either in the anterior wall of the rectum or in the perineum. The constitutional disturbances are even more marked than in suppuration of the gland proper. The swelling is, however, usually more diffuse in periprostatic abscess, and is apt to point in the posterior or anal perineum and to invade the ischio-rectal space, inasmuch as its origin is behind the middle perineal fascia.

Unless these abscesses are promptly treated the prognosis is bad, both as to life and as to the damage to the surrounding tissues.

Treatment.—The pus must be evacuated by early and free incisions through the perineum. Pointing should never be awaited; any delay permits the almost certain occurrence of extensive sloughing of the cellular tissue of the perineum, the probable occurrence of rectal fistula, and the possible loss of life.

Chronic Prostatitis.—Chronic prostatitis is relatively of much more frequent occurrence than is the acute form of the disease, but is much less understood.

Etiology.—It occurs as a sequel of acute inflammation, and also in its simple or uncomplicated form develops primarily as a chronic process. The latter variety has been ascribed to irritating injections long continued, to excessive coitus, to masturbation, to hemorrhoids, and to constipation, all of which act by keeping up a chronic congestion of the prostate and surrounding structures. In one variety it is the result of a chronic pyogenic infection, in which but small quantities of the poison gain access to the gland at one time, so that the tissues are able at least partly to resist the invasion. This condition would therefore commonly be met with in patients suffering from chronic gonorrhea, strictures, etc. It not infrequently complicates senile hypertrophy.

In addition to the causes mentioned, the long-continued exposure to cold and damp, the presence of either vesical or prostatic calculus, and mechanical injury should be mentioned.

Morbid Anatomy.—A prostate gland the subject of chronic inflammation may be found larger or even smaller than the normal size; the consistence, if any difference exists, is less firm; the texture is more open and spongy. The color of the cut surfaces has a dusky hue, sometimes with a redder tint. More fluid than is natural is found in the gland-tissue and it freely issues on exerting pressure. This fluid is of a dirty hue, and if firm pressure be made appears to be stained slightly red. In advanced cases deposits of pus are found, varying from the size of a grain of sago to that of a pea. They are, however, few in number, being in strong contrast, therefore, with the appearance in acute prostatitis in the later stages. The mucous membrane may be thinner and more vascular than normal, with the duct-orifices large. In other places it may be coated with organized lymph, giving it a roughened and opaque appearance, or its own structures may be thickened, not reddened as in acute inflammation, but presenting after death a dull gray or even slaty hue, the last-named marking long persistence of the unhealthy action. In such cases pus is often found filling the sinus pocularis and the gland-ducts around. Sometimes a cavity filled with pus communicating with the urethra marks the site of a chronic abscess. It is not uncommon to find an abscess or abscesses surrounding the gland—in other words, periprostatic abscesses depending on a previous disease of the prostate itself (Thompson).

Symptoms.—The principal symptom is the occasional discharge of a larger or smaller quantity of a clear, viscid fluid constituting the so-called prostatorrhea. Occasionally the fluid may be milky. It varies in amount from a few drops to 5 or 10 grams in twenty-four hours. This discharge, especially when in considerable amount, may be preceded by spasm of the perineal muscles. The greatest flow is apt to attend an action of the bowels, especially if the movement is constipated. The patient may also note a little troublesome tickling sensation in the urethra, some undue frequency of urination, occasional dull pains in the perineum, which are apt to be increased by exercise, and pains in the thighs or sacral region. There is apt to be pain at the end of micturition, which is, however, not nearly of so severe a type as occurs in cases of vesical calculus. There may be slight tenderness in the perineum, which makes sitting uncomfortable, and increased sensitiveness of the prostate on rectal examination. There may or may not be slight enlargement. The introduction of a catheter causes more pain than usual as the instrument traverses the prostatic urethra. The urine is apt to show a little cloudiness, which is found on examination to be mainly due to shreds of tenacious muco-purulent matter and masses of epithelium which have their origin in the prostatic urethra, as may be demonstrated by requesting the patient to pass urine into two glass vessels, the first ounce or so in one and the remainder in the other. All the turbid matter will be found in the first portion. This test would exclude bladder and renal troubles.

Other symptoms which are more or less constant are frequent and painful erections, or there may be imperfect erections and premature ejaculations, lascivious dreams, etc. A characteristic symptom is the profound mental depression exhibited by many of these patients. In pronounced cases it may result in melancholia. The importance of the various symptoms is apt to be greatly magnified by the patient. He is particularly worried about the discharge, which he invariably believes to be spermatic fluid; it is needless to say that this idea is erroneous.

In addition to the similarity that some of these cases present to vesical calculus, the condition must be differentiated from inflammation of the seminal vesicles, or seminal vesiculitis, as it is called.

The following symptoms of subacute and chronic seminal vesiculitis, the varieties most likely to be confounded with chronic prostatitis, are condensed from the description by Fuller:[1] Pain is felt in the sacral region, over the pubes, or in the bladder, or more rarely in the rectum or perineum. It is intensified by sexual excitement or emotion, which may cause sharp paroxysms lasting for some days. The pain is also intensified to a greater or less degree by constipation or diarrhea, especially if accompanied by tenesmus, and active exercise. As a rule, there is no tenderness on firm abdominal palpation. Rarely tenderness to pressure in the perineum is a pronounced feature. Sexual desire varies in different cases; it may be increased or diminished, and may vary from time to time in the same case. Abnormalities relating to the seminal emissions are usually observed; they may take any variation from the normal. Inflammation of the seminal vesicles may be the sole cause of persistent urethral discharges. In addition, a great number of reflex symptoms are described. They are, of course, in no way characteristic and may occur in very many conditions. Altogether, there seems to be nothing distinctive in the symptomatology of these varieties of vesiculitis. Many of the complaints mentioned would be suggestive, but the presence or absence of the condition must be determined by examination of the patient.

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[1] *Disorders of the Male Sexual Organs*, 1895.

A valuable aid in the diagnosis of chronic prostatitis has recently been proposed by Posner of Berlin. The method has been worked up by v. Schlen and by Krotazyner and Spencer.[1] It consists in having the patient urinate in two glass vessels, the first ounce or two in one, and a similar or greater quantity in the other, *a portion of urine still being retained in the bladder.* The prostate is now thoroughly expressed by massage with the finger in the rectum or by the instrument devised by Feleki, and the patient requested to pass the last portion of urine. In cases of chronic prostatitis this last portion was found to be cloudy; microscopic examination showed pus-corpuscles, threads, and gonococci. The writers referred to believe that the presence of gonococci in the prostatic glands is always a source of danger, and that no patient who has suffered from chronic posterior urethritis can be pronounced cured without an examination of the prostatic secretion. The only treatment of any avail in chronic gonorrheal infection of the prostate is systematic massage.

In this examination care must be observed not to express the contents of the seminal vesicles as well as of the prostate, otherwise disease of the former may be mistaken for prostatic trouble.

Treatment.—The first indication in the treatment of chronic prostatitis is to remove, if possible, the cause. Therefore if stricture, phimosis, or a contracted meatus exists, such condition should first receive attention. Erotic excitement should be strenuously avoided, as should everything else that tends to induce a congestion of the affected part. For this reason constipation is to be carefully guarded against. Many of the cases could doubtless be cured by hygiene alone if all disturbing factors could be removed. Ungratified sexual excitement and sexual excess are harmful, but moderate, unemotional intercourse need not be interdicted.

The prolonged use of counter-irritation to the perineum is of undoubted value. This may be obtained by the application of equal parts of tincture of iodine and tincture of belladonna once daily until the skin becomes sensitive, or cantharidal collodion may be applied and the resulting vesicated surface dressed with some antiseptic ointment; the blistering to be repeated after the skin has healed. A continuous effect may be obtained by applying the blistering fluid on one side of the raphé at a time, the application being made to the opposite side in three or four days, and so on alternately. The daily use of a jet of cold water from a bidet is of unquestioned value in many cases. Both the low temperature of the water and the force of the stream are efficient agents in exciting a reflex contraction of the blood-vessels, with consequent relief to the engorged organ. In other cases hot hip-baths for a few moments at a time are serviceable. They effect a dilatation and engorgement of the superficial vessels, which depletes deep-seated congestion.

In most instances the application of a solution of silver nitrate to the prostatic urethra will be followed by benefit. The application should be made by means of a syringe of hard rubber especially designed for the purpose. In the beginning not more than a few drops of a 1 per cent. solution should be deposited. By making the early applications unduly strong a high degree of inflammation will be induced, and considerable annoyance, or even suffering, unnecessarily inflicted upon the patient. The solution should be accurately placed in the prostatic urethra. This may be accomplished by introducing a catheter and marking the point at which urine first begins to flow. Knowing the length of the urethra, there will be no difficulty in determining the distance that the syringe should be introduced in making the applications of silver. The treatments should be repeated in from three days to a week or more, depending upon the strength of the solution used and upon the amount of reaction that follows, allowing the longer interval to elapse between the stronger applications. The strength of the solution is to be increased gradually to 2, 3, 4, and 5 per cent. as the toleration of the urethra becomes established. Some authors recommend much stronger applications, as, for example, a 10 per cent. solution of silver or even the mitigated or pure stick of silver. The latter is unjustifiable; it does more harm than good. The stronger solutions of silver nitrate may be demanded in rare cases, but they should always be used in very small quantity, with the greatest care, and only after having tried the weaker solutions first. They should be given while the bladder is full, so that any excessive action of the silver may be neutralized by prompt urination. If marked inflammatory action should follow any of these applications, it must be controlled by rest and appropriate remedies. (See Acute Prostatitis.)

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[1] *Journal of the American Medical Association*, July 21, 1894.

As many of the patients will be found to be more or less depressed physically, the general condition of the health should be looked after. This will include the question of diet, the condition of the digestive organs, the amount and kind of exercise, bathing, etc. As regards diet, anything which would have an irritating effect upon the urinary organs should be avoided. Such articles are cayenne pepper, mustard, sauces, vinegar, and pickles generally. Tomatoes and other highly acid vegetables and fruit are also objectionable in many cases. Any derangement of digestion should be overcome by increased care in diet and suitable medication. Moderate exercise is beneficial, but excessive exertion is to be avoided. The patient should bathe frequently, and attend to the various details of personal hygiene with the view of improving the general health and vigor. It will be necessary in many instances to reassure the patient in order to prevent him from becoming morbid in regard to his condition.

Dr. Hugo Feleki[1] considers that, theoretically, massage is the ideal rational therapy for chronic affections of the prostate and seminal vesicles. It clears out the ducts thoroughly, helps to decrease congestion, leads to the absorption of chronic inflammatory material, and finally gives tone to the muscular structures and enables nature to accomplish once more what, for the time being, massage does artificially.

Massage with the finger, as usually practised, is unpleasant to both the surgeon and patient, and besides, it is impossible always to reach the parts with the finger, as they are situated farther from the anus than is usually stated. The average distance of the upper part of the prostate from the anus is given as 7 to 7½ cm. In a series of measurements in 32 bodies at from twenty-one to sixty-four years of age, where the prostate seemed normal, the average distance of the lower edge of the prostate from the anus was 6.3 cm., and the upper margin 9.2 cm., the seminal vesicles being on an average about 13 cm. from the anus.

Feleki has devised an instrument (see p. 296) with which the patient can thoroughly massage the parts himself. The procedure lasts, according to the sensitiveness of the patient, from three to ten minutes, and may be practised two to three times a week. Very rarely does the patient complain of much pain. The author has obtained much better results with this method than with digital massage.

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[1] *Centralblatt für die Krankheiten der Harn- und Sexual-organe*, Band 6, Heft 10, Dec. 14, 1895.

Imperative urination usually ceases after four or five séances, and in most cases the feeling of fulness in the rectum and the uncomfortable or even painful sensations in the prostate disappear.

In a colleague, premature ejaculation that had existed for years, and for which everything had been tried, ceased after six treatments, and has not recurred. A number of similar cases have been successfully treated. Frequent emissions and spermatorrhea due to chronic prostatic trouble nearly always disappear after massage for some weeks. In all of these cases the author says that the usual remedies must not be neglected. The passage of sounds, as an internal massage, he especially commends, and the use of Winternitz's psychrophor he has found useful.

Swinburne[1] has devised a modification of Feleki's instrument (see p. 296) for applying massage to the prostate, and finds it very useful in many cases, although he employs the finger by preference in most instances.

Massage is also highly recommended by Güterbock and Ebermann. The latter[2] directs that the patient be placed on the back or in the knee-elbow position. The operator introduces a finger into the rectum and rubs the gland from left to right, and *vice versâ*, pressing toward the symphysis. The séance may last five to ten minutes or even longer, and may be repeated every day or second day. Pathological products are thus driven into the veins and lymph-currents.

Abscess of the Prostate.—Acute inflammation of the prostate may be followed by chronic prostatitis, as has been mentioned, or it may result in the formation of an abscess. The latter will be more apt to occur in neglected cases and in those in which the health is below par. Suppuration may take place early in the course of the disease or as a late result. There may be a single abscess or several, which later coalesce, forming one large cavity.

Symptoms.—The occurrence of suppuration in the course of an acute prostatitis may be suspected when the symptoms have not ameliorated at the end of about a week, if the temperature does not subside, if there is a throbbing sensation at the seat of the trouble, and especially if rigors occur. The diagnosis will be confirmed if it is possible to detect fluctuation by rectal examination.

These abscesses open spontaneously into the urethra in the majority of cases. Occasionally the collection is evacuated during the act of passing a catheter to relieve retention. In other cases the pus is discharged into the rectum. The latter is rather an unfavorable termination, inasmuch as a urethro-rectal fistula may remain. Evacuation by the urethra is usually followed by rapid shrinking of the abscess-cavity and cure; this is considered a favorable termination. In rare instances the obliteration of the sac may fail to take place. In such cases a focus of chronic suppuration remains.

Treatment.—As soon as the presence of a prostatic abscess can be detected it should be evacuated through the perineum. The proper method consists in introducing the left fore finger into the rectum and locating carefully the fluctuating point; then without removing the finger a long, straight, and narrow bistoury, the cutting edge of which is upward, should be thrust into the raphé about $\frac{3}{4}$ of an inch anterior to the anus until the abscess is reached, the point of the knife being guided by the finger in the rectum. The incision should be enlarged upward sufficiently to give free exit to the pus. The depth of the incision will probably be 1½ to 2 inches. It is obvious, of course, that the surgeon should be satisfied as to the presence of pus before proceeding to carry out this operation. The urethra should be avoided in making the incision.

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[1] *American Medico-surg. Bulletin*, Mar. 28, 1896.

[2] *Intern. Centralbl. f. d. Physiol. u. Pathol. d. Harn. u. Sex.-org.*, Leipzig, 1891–92, iii.

In completing the operation the cavity should be thoroughly explored with the finger, all partitions broken up, and the wound well irrigated with an antiseptic solution. Occasionally, profuse hemorrhage may be encountered, but this can be controlled by packing iodoform gauze directly into the bottom of the wound. Incision through the wall of the rectum should be performed only in those cases in which the abscess appears in this situation just beneath the mucous membrane.

Prostatic Gout.—As Reginald Harrison has pointed out, there are certain affections of the region about the neck of the bladder that we cannot do better at present than designate "prostatic irritation," and of these the most common is found in gouty patients, where the irritation is so intense as to amount almost to an inflammation. Many cases that are described as neuralgia of the prostate are simply illustrations of this affection.

Symptoms.—Like gout affecting the great toe, the paroxysm comes on usually at night. It is referred to the neck of the bladder. Urination is irresistible, although painful, and spasmodic, sympathetic pain often attacks one or both testicles. The patient is sensitive to rectal examination. The urine is highly acid, deposits urates, and contains an excess of mucus. During the day the symptoms are generally in abeyance, but they recur at night with unabated force.

After such a paroxysm the prostate is unusually sensitive for a considerable time. As a consequence the patient dreads to exercise pressure upon the gland by completely emptying his bladder. Retention of urine under these circumstances is not only a fruitful cause of cystitis, but also predisposes to vesical calculus.

The **diagnosis** of prostatic gout can be made easily by the exclusion of inflammatory lesions and by the history of gout. It usually merges into a chronic form of irritation unless actively treated.

In the **treatment** of this form of "irritable prostate," both in the acute and in the chronic variety, reliance must be placed chiefly upon the correction of the state of the urine and the use of remedies which usually relieve the manifestations of gout. Patients who habitually suffer from this trouble are often greatly benefited by periodical visits to saline springs.

Prostatorrhea.—The discharge of a colorless or milky, viscid, mucoid fluid from the meatus, appearing sometimes after the spasmodic contractions at the end of urination or during the act of defecation, constitutes the condition known as prostatorrhea. Authorities differ as to whether this should be considered as a disease *per se* or as a symptom of chronic inflammation of the prostate. In some cases the discharge of the characteristic fluid is the only symptom present, but there is reason to believe that the condition depends at least upon a chronic congestion, if not inflammation, of the gland. This subject has therefore been considered under the heading of Chronic Prostatitis, to which the reader is referred.

Hypertrophy of the Prostate.—The term "hypertrophy" seems rather more appropriate than "enlargement" as applied to the condition under consideration, inasmuch as it expresses the pathological condition present. It is contended by some, among whom are Socin, and it may be admitted, that in certain cases the condition is more like a tumor-formation; but the new tissue is the same as that normally found in the prostate. Accepting this distinction, a circumscribed overgrowth would be termed a "hyperplasia," and a uniform increase in size an "hypertrophy." The latter term may be used, however, to include both conditions.

In a certain proportion of men the prostate shows an inclination to increase in size after the fiftieth year of life. It doubtless begins earlier in some instances, but more frequently at a later period. Belfield[1] refers to the following instances of enlargement of the prostate occurring before the fifty-sixth year, the earliest period at which Thompson had observed the affection: "McGill removed a prostatic collar 'the size of a large walnut' from a man aged fifty-three; M. Schmidt a large middle lobe from a man aged fifty-two; Belfield a prostatic growth from a patient aged forty-nine; Iverson described a case at thirty-six, which Güterbock says is no rarity; H. G. Mudd exhibited an extreme example of prostatic hypertrophy from a negro aged twenty-seven (the prostate and its outgrowths literally filled the true pelvis; on microscopical examination the growth was found to be a true fibro-myoma with no suspicion of malignancy); and Dr. Mudd referred to a case of true prostatic hypertrophy in a child five years old."

Varieties.—The following forms of enlargement can be recognized: (*a*) a uniform increase of the glandular and stromal elements, constituting a true hypertrophy. In these cases the gland is uniformly enlarged, but does not reach a great size, and seldom causes symptoms of importance. (*b*) Overgrowth of the stroma, the fibrous connective tissue being chiefly involved, without much change in the muscular elements. This form may attain a large size, and is that most commonly met with. (*c*) In a third class the overgrowth of glandular tissue predominates over the stromal. This form of enlargement is rarely permanent. Usually the glandular hyperplasia disappears sooner or later, and is replaced by fibrous tissue of greater density. (*d*) A localized overgrowth. This form is commonly met with. These small tumors are found in almost every case of hypertrophy of the prostate, and seem to be confined to no one particular portion. According to some authorities, they are merely areas of marked local hypertrophy, enlarging more rapidly than the surrounding tissue. The enlargement is always confined within the capsule of the gland, although certain portions, enlarging more rapidly than others (*e. g.* the small tumors just mentioned), may extend a considerable distance from the gland, pushing the capsule ahead of them, and remain connected with the prostate only by a thin band of glandular and fibrous tissue.

Changes in the Prostate noted in Hypertrophy.—The earliest change observed is that the prostate as determined by digital exploration through the rectum is thicker and more rounded than is natural. The margins of the organ are more easily defined; usually the gland is firmer in consistence, and seems to be composed of one mass rather than of the two-lobed formation which is normally felt. According to Thompson, a prostate weighing 7 drams must be considered enlarged. He has examined those weighing less than 6 drams that afforded unmistakable evidence of the existence of hypertrophy. In this stage the only increase of dimension may be in the thickness, the length and the transverse diameter not being much altered.

Every degree of enlargement is to be noted, from that just mentioned to the size of a closed fist, an orange, or a cocoanut. The hypertrophy may be general, affecting the whole organ symmetrically, or there may be a general enlargement, in which, however, one portion participates in the change to a greater extent than others, and an irregular tumor results. Occasionally one lateral lobe is chiefly affected, but it is common for the other to be involved to some extent. Adami [1] believes that the reason for circumscribed enlargement of the prostate lies in the fact that the gland arises as a series of acini, each of which is surrounded by a coat of plain muscular tissue, while at a later date groups of these acini become surrounded by a common sheath of muscular or fibro-muscular tissue. These acini being at least partly independent, certain ones may take on enlargement. Adami could not determine whether the ducts of the acini became occluded or not. Sometimes the enlarged gland will present independent tumors arising from some portion of the surface. In other instances the median portion becomes

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[1] *Am. Jour. Med. Sci.*, n. s., vol. c, 1890.

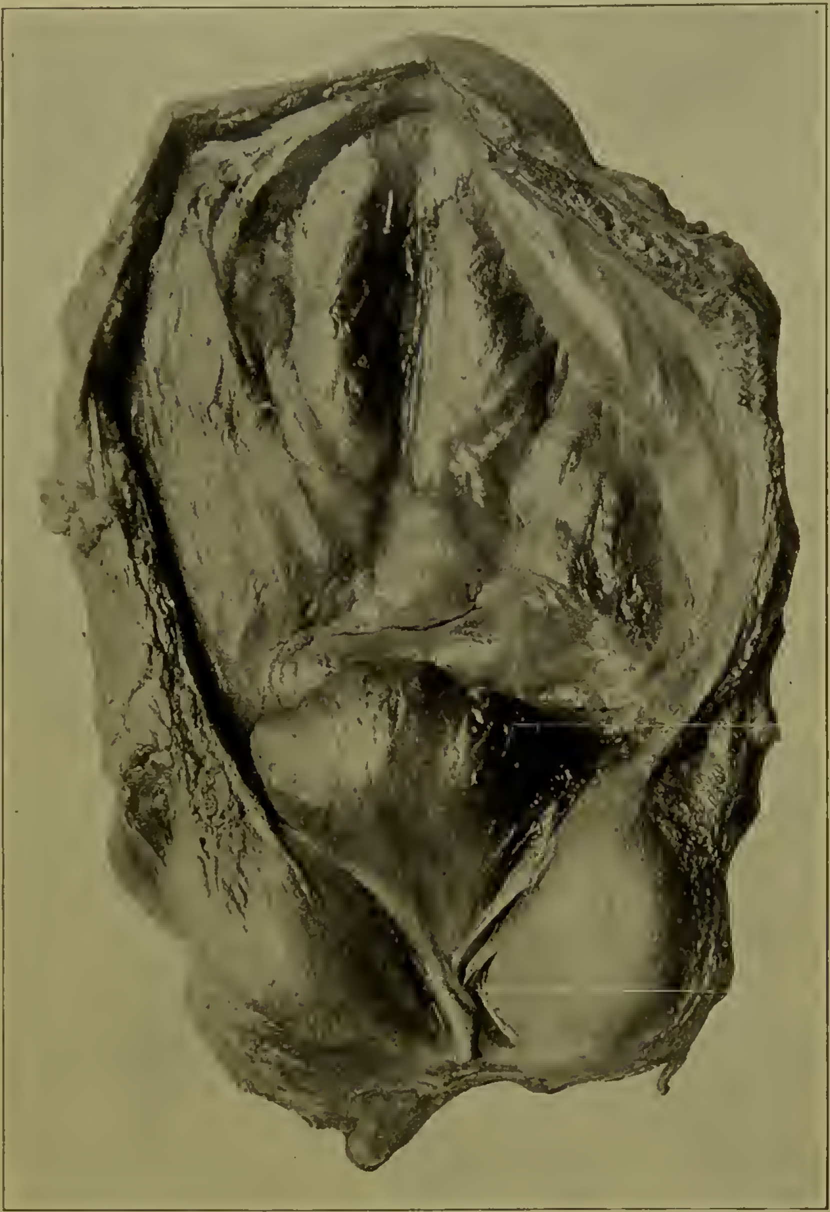

FIG. 73.—General enlargement of the prostate. The divided surfaces of the supra-urethral portion and the large median lobe show well. Catheterization was possible in this case only with a metal prostatic catheter, the point of which invariably turned to the patient's left on entering the bladder; profuse bleeding always followed the introduction of the instrument. *A*, point in middle lobe against which the catheter impinged and from which the hemorrhage came: *B*, verumontanum.

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[1] *Montreal M. J.*, 1892–93, xxi. 647.

enlarged greatly out of proportion to the change in the other parts of the organ. It has been asserted that an increase of one-half centimeter (three-sixteenths of an inch) in the length of the prostatic urethra is indicative of hypertrophy.

Regarding the frequency with which the different portions of the prostate are involved we have now considerable evidence. Thompson examined carefully 123 specimens with the following result: Of the common forms of the affection he found—(1) general enlargement of the prostate—that is, both lateral lobes and the median lobe were pretty equally enlarged in 74 cases

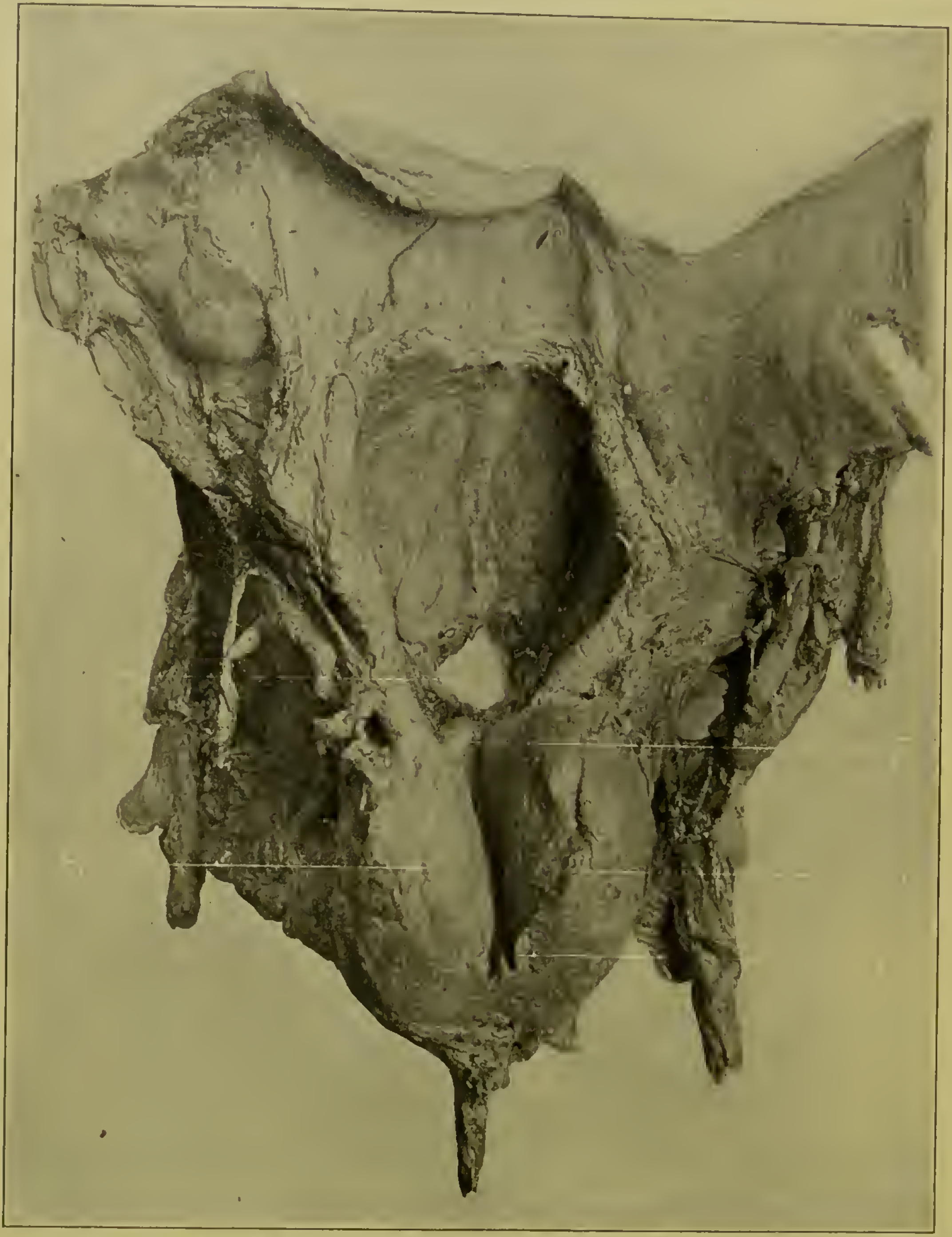

FIG. 74.—Moderate enlargement of the lateral lobes of the prostate. This case was complicated with a vesical calculus. *A*, perforation through the *bas fond* of the bladder, due to pressure-necrosis from the stone, which remained fixed in one position; *B* and *D*, the cut surfaces of the supra-urethral portion of the prostate; *C*, floor of urethra; *E*, very slight enlargement of the median lobe.

(about 60 per cent.); (2) general enlargement of the prostate, in which the median portion was hypertrophied to a greater extent than the remainder in 19 cases (about 15 per cent.); (3) general enlargement, but with the right lobe very decidedly larger than the left in 8 cases (about 6 per cent.); (4) general enlargement in which the left lobe predominated distinctly over the right in size, 11 cases (about 9 per cent.). Among the uncommon forms of enlargement he found (5) the lateral lobes only affected in 5 preparations (about 4 per cent.); (6) the anterior commissure only or chiefly enlarged in 3 preparations (about 2 per cent.); (7) the lateral lobes and anterior commissure enlarged, but not the median portion, in 33 instances (about 2 per cent.). These results correspond approximately with those arrived at by Messer, Vignard,[1] Watson,[2] and others; an analysis of the cases quoted shows that—(*a*) The lateral lobes and the median portion are equally liable, or nearly so, to be affected with hypertrophy; (*b*) that the posterior commissure is generally involved with the preceding enlargements, and in proportion to the

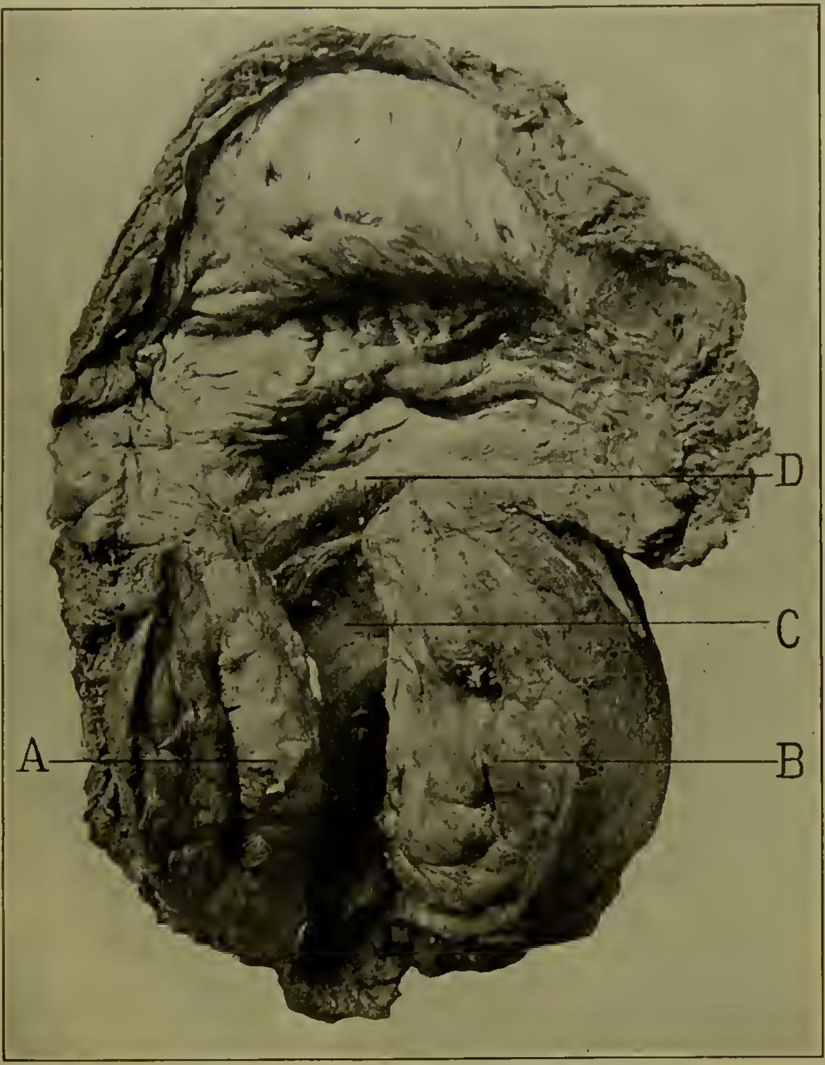

FIG. 75.—Enlargement of the lateral lobes of the prostate, most pronounced on the left side: *A* and *B*, incision through prostate from urethra; *C*, floor of prostatic urethra, very much broader than normal; *D*, very slight enlargement of median lobe. The size of the prostate will be appreciated by comparing it with the bladder, which is here shown entire.

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[1] *De la Prostatomie et de la Prostatectomie*, Paris, 1890.

[2] *Operative Treatment of the Hypertrophied Prostate.*

extent which they manifest; (c) that the anterior commissure is not frequently affected, but nevertheless is so in rare instances; (*d*) lastly, the enlargement takes place at about an equal rate in each of the three principal divisions, in some cases the lateral lobes appearing to enlarge more rapidly than the median portion; in others the contrary is found, and perhaps in a rather larger number of cases than in the preceding.

According to the studies already referred to, about 300 grains may be considered the weight of the normal prostate. When the gland has increased to 400 grains, or about 7 drams, it is considered pathological. In 20 examples of hypertrophy of the prostate dissected by Thompson the weight ranged from 6 drams and 20 grains to 18 drams, the average being about 9 drams and 15 grains. Dr. Messer's dissections included 35 specimens, which ranged in weight from 6 drams and 15 grains to 48 drams, the average being 15 drams. The largest recorded example weighed about 75 drams and in size approached that of an ordinary cocoanut.

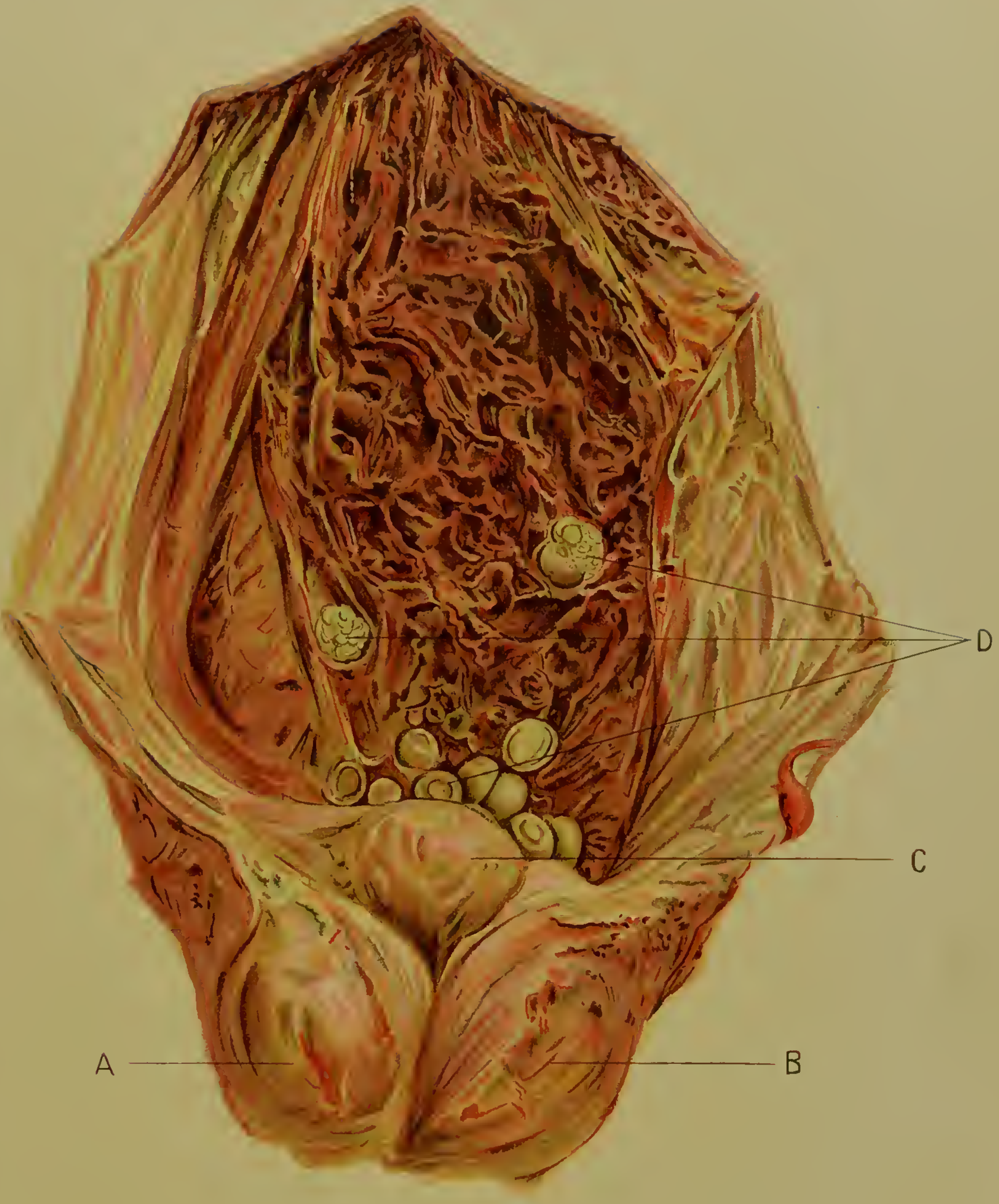
Changes in the Urethra and Neck of the Bladder.—The internal sphincter may be considered an integral part of the prostate, hence any alteration in the structure of the latter would be followed by interference with the function of the former. In addition, as the prostate is limited in front and below by dense fascia, it tends to grow upward and backward as it hypertrophies, elongating and narrowing or deflecting the urethra according to whether the enlargement be symmetrical or irregular, and always raising the vesical outlet to a higher level than normal. As the base of the bladder remains stationary, while the neck rises in proportion to the degree of prostatic enlargement, a pouch is formed behind the prostate, which makes complete evacuation of the bladder difficult or impossible. The urine thus remaining after each act of micturition is called "residual" urine. The amount gradually increases as the obstruction becomes more marked and the power of the muscular coat of the bladder diminishes. The increased frequency of urination and the greater force necessary to overcome the obstruction lead to dilatation of the bladder with overstretching of the muscle, and atony results. In some cases the bladder-wall becomes much thinned from the extreme distention; in other cases the muscular trabeculæ become enormously hypertrophied, the inner layers of which form pronounced ridges beneath the mucous membrane. These by their powerful contraction exert considerable pressure upon the vesical contents, which leads to dilatation and sacculation in such parts of the bladder as are not supported by these strong muscular bands. The hypertrophy and sacculation are further increased by the vesical irritability incident to venous congestion at the neck of the bladder.

Hypertrophy of the prostate strongly predisposes to the formation of vesical calculi, especially if residual urine also be present. Plate 3 illustrates a bladder containing numerous calculi. The specimen also shows well the hypertrophied trabeculæ and the sacculation that are so frequently met with. The mucous membrane was very deeply injected. Death in this case was due to ascending pyonephritis.

The size of the bladder varies greatly. In the cases in which the obstruction has not been marked and the bladder has been frequently emptied it may be so contracted as not to hold more than two to four ounces; in other instances, in which there has been marked obstruction and chronic retention, the capacity may be as much as four pints.

An early effect of prostatic hypertrophy is congestion, and later inflammation of that portion of the mucous membrane of the bladder in contact with the tumor. The inflammation spreads in time, being aggravated by the

PLATE 3.



General enlargement of the prostate; sacculation of the bladder-wall; numerous calculi. The bladder has been opened in front, and the prostate divided from the roof of the urethra directly upward. *A* and *B* represent the cut surfaces of the prostate, widely separated, showing the tension that existed; between these is the floor of the urethra; *C*, enlarged median lobe; *D*, numerous vesical calculi; behind the middle lobe a nest of these is seen.

sluggish venous return. In this condition the mucous membrane offers but slight resistance to microbic invasion. The presence of pathogenic microbes in the bladder frequently depends upon the introduction of instruments that have not been surgically clean, or the germs may have been carried in by failing to cleanse the anterior urethra before the instrument was introduced. Cystitis develops, however, independently of these causes. The infection may be conveyed by way of the urethral mucous membrane apart from instrumentation, or may gain access, as claimed by some authors, through the kidneys, or, as shown by others, directly through the walls of the rectum and bladder. According to the researches of Clado and Albarran, septic cystitis almost invariably depends upon the bacterium pyogenes. This is said to be identical with the bacillus coli communis. As a result of the irritating properties of the germs themselves or their ptomaïnes an intense inflammation of the vesical mucous membrane is caused. The urea is decomposed and ammonia is set free, which acts as a further irritant.

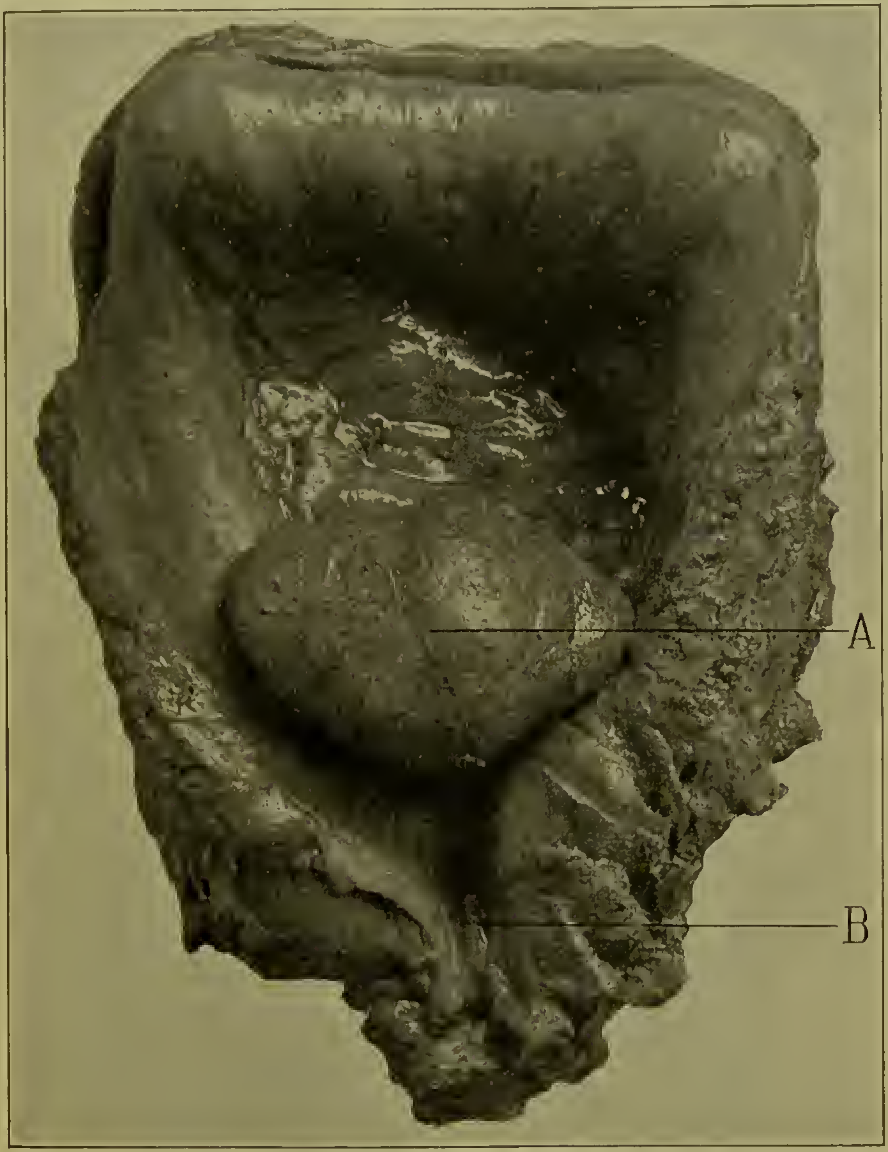


FIG. 76.—*A*, very large median lobe; *B*, floor of urethra (verumontanum). No enlargement of the lateral masses. (Original.)

The important change produced in the bladder from the standpoint of the surgeon is the loss of power to evacuate its contents even when the mechanical obstruction is relieved. This may be due to over-distention, sacculation, or more commonly to crippling of the detrusor muscles as a result of the chronic obstruction.

In the early stages of hypertrophy of the prostate there are an increase in the antero-posterior diameter of the prostatic urethra and a diminution in the lateral or transverse diameter, whereas in the healthy state both dimensions would be equal. The narrowing of the canal is due to the encroachment of the lateral lobes. The length of the prostatic urethra is always increased. Its normal length is about one and a quarter inches. Thompson records having observed cases in which the prostatic urethra has measured three inches, and White observed a case in which this measurement was three and a half inches. In addition to the increase in length, the prostatic urethra becomes more curved than in its normal condition; in some instances a distinct angle is formed. If the enlargement affects one lateral lobe more than the other, the urethra will be deviated to the opposite side. Whether the hypertrophy affects either one or both lateral lobes, the median lobe is generally found enlarged also, but not invariably, as is well shown in Fig. 75. In Fig. 76, the vesical end of the urethra being divided by the large median outgrowth, a passage is left on either side of it, giving to the canal the form of the letter Y. The vesico-urethral orifice becomes distorted, depending upon the degree and nature of the enlargement.

In rare cases the result of enlargement of the prostate is the reverse of obstruction. There is then a genuine incontinence in contradistinction to the incontinence of retention that is commonly observed.

Morbid Anatomy.—When a section is made through a prostate the sub-

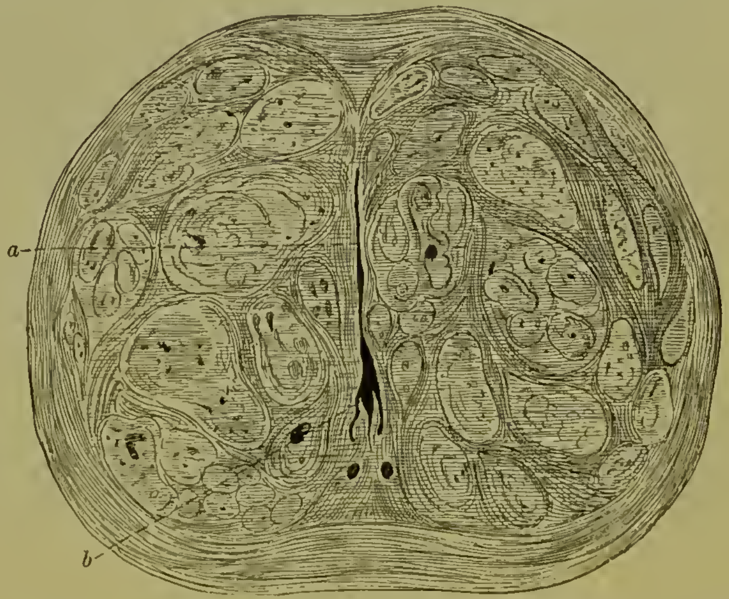


FIG. 77.—Section of hypertrophied prostate of a man aged 74 years; natural size (Socin): *a*, urethra; *b*, colliculus seminalis.

ject of marked hypertrophy, the cut surface protrudes more than the normal gland, and is moreover irregular, showing the tendency that exists for certain centers to develop more than others, as has already been mentioned. The cut surface displays an irregular coloring due to trabeculæ of a grayish-white or grayish-red color, which surround yellowish-white foci, varying in size from that of a millet seed to that of a pea. This irregular coloring is much more pronounced than in the case of the normal organ. Microscopic examination does not reveal any new elements. The enlargement consists entirely of an increase in the structures normally present.

The Occurrence of Tumors in Connection with Prostatic Hypertrophy.—Although benign tumors are found in what appears to be otherwise a normal prostate in rare instances, their presence is much more common in connection with hypertrophy of the organ. Thus in three-fourths of the hypertrophied specimens examined by Thompson tumors were present. Messer reports having observed isolated tumors in 27 of a series of 35 hypertrophied prostates which he examined. These tumors are of two varieties—namely, those which are imbedded in the substance of the prostate, but which are isolated from the surrounding structures; and those which, although continuous with the part of the gland from which they spring, manifest a tendency to become isolated and pedunculated.

When the tumors appear in the substance of the prostate they are apt to be encapsulated. Their consistence is rather firmer than that of the normal prostatic tissue.

Any part of the prostate may become the seat of a well-defined, more or less pedunculated growth. The median portion is, however, the most frequently affected. The shape of the growth is apt to be pyriform. These growths vary in size from that of a pea to that of a pear. The anatomical location of these tumors tends to interfere greatly with the function of micturition. Enlargement of the median portion occurs usually in connection with more or less general hypertrophy of the organ.

The analogy between these tumors and uterine fibroids was first pointed out by Velpeau. This view was later elaborated by Sir James Paget and others.

Etiology.—Many theories have been advanced in explanation of the occurrence of enlargement of the prostate gland. It is known, of course, to belong to the period beyond middle life, but why only a certain portion of individuals should be affected has not been satisfactorily explained.

Sir Everard Home,[1] who devoted a good deal of study to this subject, believed that the chief predisposing cause was "the slow return of the blood from the neck of the bladder, arising from the disadvantageous situation of the veins respecting the heart." It is known that the veins of the prostatic plexus become dilated, and that the valves shrink or disappear or the coats of the vessels undergo calcareous degeneration. The result of all this would be an habitual congestion of the part. Sir Astley Cooper considered the enlarged prostate the consequence of age, and not of disease. Velpeau was of the opinion that hypertrophy of the prostate depended on the presence of tumors. Sir Benjamin Brodie regarded hypertrophy of the prostate as a part of a general senile change. He says: "When the hair becomes gray and scanty, when the specks of earthy matter begin to be deposited in the tunics of the arteries, and when a white zone is formed at the margin of the cornea, at this same period the prostate gland usually—I might, perhaps, say invariably—becomes increased in size."[2] Mercier regards as predisposing causes "all those which favor stagnation of the blood." He believes "there is a certain relation between a weakness of the inferior veins and hypertrophy of the prostate." Inflammatory action, as pointed out by Thompson, would be antagonistic to, rather than favorable to, hypertrophy, because nutrition would be impeded as a result, not encouraged.

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[1] *Practical Observations on the Treatment of the Prostate Gland*, vol. ii., Lond., 1818.

[2] *Lectures on the Urinary Organs*, 4th ed.

Among the more recent views that have been offered may be mentioned (*a*) that of Guyon, which regards hypertrophy of the prostate as a part of a general condition peculiar to advanced years, characterized by widespread degenerative changes and by the over-production of fibrous tissue; in other words, a disseminated arterial sclerosis or general atheroma, not limited to the vessels of the genito-urinary system, but when occurring in them producing both the prostatic hypertrophy and the rigid or feeble bladder, with their resulting symptoms.

(*b*) Harrison believes that the primary change takes place in the bladder itself, and the depression of the posterior wall, which is said to occur as the bladder sinks into the pelvis with advancing years, precedes prostatic obstruction, and is compensated for by the development of a muscular buttress between the orifices of the ureters, tending toward the obliteration of what would otherwise prove to be an inconvenient pouch.

(*c*) The theory suggested by Velpeau, and which seems to us to more nearly correspond with the facts than any of the others mentioned, considers the growth or growths which make up the enlargement in prostatic hypertrophy as analogous to the fibro-myomata so frequently found in the uterus.

In support of the first of these it is claimed that general atheroma and hypertrophy of the prostate occur at the same period of life and are commonly found in the same individual. As has been already pointed out,[1] atheroma is to be found associated with other diseases which appear by preference after middle life, as, for example, carcinoma; but no one would think of constructing from this a theory of causation. This theory is further negatived by the fact that the common result of arterial sclerosis is atrophy; that recent investigations show that the beginning of prostatic enlargement occurs earlier in life than was formerly supposed (Griffiths and others); and that the original growth is glandular, which would not likely result from atheromatous disease. Additional evidence in opposition to this view is added by the observations of Bier, who has performed ligation of the internal iliac arteries in 5 instances, and Meyer, who has operated in 3 cases for hypertrophy of the prostate. In none of these cases was arterio-sclerosis observed. The vessel-walls in every instance were soft and normal.

The work of Casper is very significant in this connection. Casper[2] examined microscopically the prostate glands of 28 old men. He found hypertrophy present in 24 instances, and arterio-sclerosis without hypertrophy in the remaining 4 cases. In the 24 cases in which hypertrophy was found evidence of arterio-sclerosis was observed in the aorta in all, in the kidneys 8 times, in the vesical arteries 8 times, in the vesical arterioles 9 times, and in the prostatic and periprostatic vessels 4 times.

The bladder and prostate were affected in 2 cases, the kidneys and prostate in 3 cases, and the kidneys and bladder in 3 cases. The nearest approach to a general arterio-sclerosis of the urinary tract was observed in 2 cases, in which the kidneys, the bladder, and the prostate were affected. These results clearly disprove the theory of Guyon and the French school.

The second view presupposes that the prostate is primarily a urinary organ. If this theory be correct, the hypertrophy of the prostate must be considered compensatory in nature, and due to the changes in the tonicity and in the position of the bladder itself, as well as to the more frequent demands made upon it in adult life to retain for a long time considerable quantities of urine. As soon as a little pouching of the trigone takes place residual urine remains. The efforts to expel this cause the development of the interureteral bar, and later of general prostatic overgrowth.

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[1] White: *Annals of Surgery*, Aug., 1893.
[2] *Centralblatt für Chirurgie*, No. 13, 1894.

It is now known beyond a question of doubt that the prostate is a sexual organ, and is not related to the urinary tract except by accidental position. This is shown conclusively by its embryology and by its comparative anatomy and physiology. While the prostatic urethra arises with the bladder from the allantois, the prostate is entirely distinct from the rest of the urinary passages, and remains so in some instances of hermaphroditism in man, and invariably in the monotremata the prostate itself originates as regards its glandular portion from the mucous surface of the urogenital sinus, and as regards its stroma from the genital cord surrounding the Wolffian ducts behind the allantois and quite distinct from the bladder.

The function of the gland is chiefly sexual, its secretion serving to surround and protect the spermatozoa, or, as Finger supposes, to vivify them, and the muscular portion to secure the discharge of this secretion into the urethra. The gland, like the testicles, remains small until puberty, when both undergo rapid evolution and soon attain full size. Furthermore, the prostate is well developed in many animals in which the horizontal posture precludes the idea that it is functionally merely a continuation of the circular fibers of the bladder. Hypertrophy has also been observed in dogs and other animals. The view held by Harrison is further contradicted by the facts to be presented in connection with the explanation of prostatic hypertrophy next to be considered—namely, that the growth or growths which make up the enlargement in prostatic hypertrophy are analogous to those fibromyomata so frequently found in the uterus. It must be admitted at the outset that it is possible to offer certain objections to this theory, and even if true it could scarcely be said to be a full explanation of their occurrence; but it is certainly the only theory that has thus far given any plausible working basis in regard to the etiology, and consequently the treatment, of this common affection.

The arguments in favor of this view, as formulated by Thompson, are as follows: The prostatic vesicle is the analogue of the sinus genitalis in the female—the uterine and vaginal cavities; the structure of the prostate and of the uterus is strikingly similar, and would be almost identical if the tubular glands found in the inner walls of the uterus were prolonged into its substance; the histology of the growths themselves is equally similar, differing chiefly in the predominance of the glandular element in prostatic tumors; the varieties of the growths, from small and encapsulated tumors easily shelled out or polypoid growths intimately connected with the uterus or prostate, up to the enormous tumors which far exceed the original bulk of the organ itself, are identical; or there may be in either case a general hypertrophic enlargement affecting the whole organ; lastly, these disturbances occur at about the same time in the sexual life of the two sexes—that is, during the latter half of the reproductive period. This ends sooner in the female than in the male, and accordingly we find the growths appearing in the former at a somewhat earlier age.

This series of striking analogies, long ago suggested by Velpeau, we have adopted as being more rational than any so far brought forward. No other view has been advanced which at all explains either the cause of these growths, their spontaneous disappearance (or failure to appear) at a certain time of life, or their cure by castration. Among other recent writers Kümmel adopts this theory.

Impressed with the analogy above described, Dr. White laid before the profession, in a paper read before the American Surgical Association at Buffalo, June, 1893, the theoretical and experimental reasons for believing that castration might have the same effect upon prostatic hypertrophy that oöphorectomy has upon uterine fibro-myomata.[1] The author's only experience at that time had been with dogs having normal prostates, but the results bore out this theory in the most striking manner. Following this paper, cases of castration were reported in which the results were so uniformly successful in relieving the patients that it was apparent that an addition of some definite value had been made to the treatment of the condition in question.

With this evidence an effort was next made to explain the etiology of these prostatic overgrowths and the effect which had been found to follow castration. The following views were embodied in a paper read before the American Surgical Association in June, 1895:[2] The testicles, whose highest and most specialized function is to produce spermatozoa for the propagation of the species, seem, like the thyroid, to exert a widespread influence over general nutrition and development. This is also true of the ovaries. "In man, as in the rest of the vertebrate animals, the male and female organs in the original state of the germ are entirely the same, and the differences of the two sexes only gradually arise in the course of embryonic development (in man in the ninth week of embryonic life) by one and the same gland developing in the female as the ovary and in the male as the testicle. Every change of the female ovary, therefore, has a no less important reaction upon the whole female organism than every change of the testicle has upon the male organs."[3] The removal of either testicles or ovaries in early life usually changes profoundly all the characteristics, physical and mental, of the individual. There is, however, abundant evidence[4] to show that the testicles may lose or may never have had the sperm-producing power, and still possess the quality which enables them to hold the organism in its normal groove and to invest it with the full attributes of masculinity.

When both testes fail in their descent they are incapable of producing spermatozoa, and in consequence the person is sterile. This has been shown by Hunter, Astley Cooper, Curling, Griffiths, and others, and is undoubtedly the rule, although there are occasional exceptions. In spite, however, of the imperfection of the organs, such a person acquires all the external bodily characteristics of the male, and is in all respects, except in the power of procreating, like an ordinary man.[5] It is not known whether this influence is exerted through a chemical product or not, but the fact that some indubitable effects are produced on the whole system by the injection of watery extracts of the testicles would seem to favor this idea.

"The function of the testes is therefore clearly twofold—viz. (1) to control and determine the development of the characteristics of the male sex; and (2) to produce spermatozoa for the reproduction of the species. These two functions are usually exercised together, but that the former may be active when the latter fails seems to indicate that the production of spermatozoa is the more specialized property and attained with more difficulty. The manner in which this sexual effect of the testes is produced, whether through the nervous system as an ordinary reflex or through the medium of some substance produced by the seminal cells (whether they form spermatozoa or not) and absorbed into the system, which by influencing the nerve-centers or in some other way controls growth and nutrition, is not known. . . . . During the last few years a watery extract of the thyroid gland has been administered with signal success in myxedema, in which disease the thyroid gland atrophies and ultimately disappears. The disease myxedema arises from the want of the influence of some unknown substance, which the thyroid gland, as is supposed, elaborates upon the nutrition-centers of the central nervous system. It may be that the testis in like manner elaborates, irrespectively of its spermatic secretion, some chemical substance which by a similar influence not only controls the growth and development of the body at puberty, but maintains the manly characters then acquired throughout life."[1]

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[1] *Annals of Surgery*, Aug., 1893.

[2] J. William White: *Annals of Surgery*, July, 1895.

[3] Haeckel: *The History of Creation*, vol. i. p 244.

[4] Curling, 4th ed., p. 14.

[5] Griffiths: *The Lancet*, Lond., March 30, 1895.

Whatever its mode of action, however, it is probable that the need for this occult property of the sexual glands would begin to disappear after their essential purposes have been subserved—*i. e.* after full adult life has been reached and the individual cast in the mould intended by Nature. This need abrogated, there would yet remain the function common to both sexes, that of producing cells endowed with the property of perpetuating the species. The testicle and the prostate would thus at this time have a closer physiological resemblance to the ovaries and uterus than at any other period of life. Both ovary and testicle would still possess the power of propagation, and with it a marked effect upon all the accessory sexual organs, while at the same time the necessity for a certain controlling influence would have been removed, and larger opportunity afforded for aberration in the growth and structure of the tissues involved. This may specially be the case, as with the cessation of the necessity for the exercise of this function (or for the evolution of the hypothetical product in question) the activity of the testicle does not cease. The organ (that it may be able to perform the other half of its work, the generation of spermatozoa) is still preserved from atrophy. Nothing in the little we know of the origin of the so-called benign growths in the body contradicts the theory that overgrowth of normal structures may be favored or hindered by changes in the nervous and vascular supply of the region. The disappearance of the necessity for a given product without the coincident disappearance of the vital energy which was expended in producing it might conceivably result in hypertrophy of organs intimately associated with those which were the source of supply. Griffiths says[2] the whole genital system is an apparatus the potentiality of which mainly depends upon the integrity of the testicles, one or both; they control the extent to which the remainder of the sexual apparatus grows, the growth of the vas deferens no less than that of the prostate and other accessory sexual glands. Such a modification of the natural ovarian and testicular functions as has been suggested would, so far as the development of uterine and prostatic overgrowths was concerned, be equivalent to a failure of the *general restraining force* which Williams[3] believes regulates the growth and development of the tissues and organs in relation to each other and to the organism as a whole. The persistence of what might be called unexpended energy during the ovule- and sperm-producing life of the ovaries and testicles respectively, might thus offer a reasonable explanation of the overgrowths in question, while the final atrophy of these organs would similarly be accompanied in many cases by such a withdrawal of nervous and vascular supply as to prevent the occurrence of hypertrophies, or even to cause their disappearance if they had already formed.

Symptoms.—The symptoms of hypertrophy of the prostate are not referable to the gland itself, but to adjacent organs, the function of which is interfered with by the changed relations due to the enlargement. A certain—perhaps fairly large—number of patients with but moderate hypertrophy are never aware of any symptoms that would lead them to suspect the presence of this condition. There may have been some increased frequency of urination, noticed at night particularly, more or less difficulty in starting the stream, which lacked its usual force, absence of the normal parabolic curve, and incomplete stoppage, resulting in some dribbling at the end of the act. Most patients ascribe these symptoms to the natural weakness of advancing years, and it is only when symptoms arise that become distinctly annoying that the surgeon is consulted.

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[1] Griffiths: *Loc. cit.*

[2] *Op. cit.*

[3] *Diseases of the Breast*, p. 138.

In the more pronounced cases the symptoms mentioned are more marked. The desire to urinate becomes more and more frequent. In some advanced cases the patient is obliged to attempt to empty the bladder every hour, half hour, or even oftener day and night. The difficulty in starting the stream gradually increases, so that a few minutes of fruitless efforts are sometimes passed before the act is finally accomplished. The stream is expelled slowly and with much more delay than normal. In severe cases the act is attended with pronounced burning sensations that not infrequently amount to agony. The diurnal frequency of urination varies from twice to many times the normal, depending upon the stage of the disease. The increased frequency of micturition in the early stages is probably due to a congestion, or even a mild chronic inflammation, of the mucous membrane of the prostatic urethra and neck of the bladder—a urethro-cystitis or prostato-cystitis. After the bladder has developed a post-prostatic pouch the capacity is reduced by the amount of residual urine present, so that the normal capacity for the individual bladder is reached correspondingly more quickly than if it had been completely emptied at each act of urination. The presence of residual urine is never suspected by the patient. The greater frequency of urination at night is a symptom which calls for explanation. It is contrary to what one would expect, as an irritated organ is usually much more quiescent during repose. It is in strong contrast with what is observed in cases of vesical calculus. This symptom has been denied by some writers, who believe that it is apparent only. During the day the attention of the individual is absorbed in his regular duties, and the conveniences are such that the successive acts of micturition are not noted. This is not true, however, at night, when the person is disturbed from sleep by the desire to pass urine. The consensus of opinion, however, is certainly in favor of a greater nocturnal frequency. The symptom is probably due to the fact that the vesical sphincter has become weakened by the prostatic overgrowth, and the urethral orifice, being not infrequently somewhat expanded, permits a few drops of urine to ooze into the sensitive prostatic urethra during sleep when voluntary control is lost, and these few drops of urine are sufficient to stimulate the desire to urinate. It is not due to any change in the quantity or quality of the urine, nor does it depend upon the position of the patient, as is shown by the fact that urination is not more frequent during the daytime when the patient remains recumbent. It may also be that during the first sleep of the night the patient passes a longer period without voiding the urine than through the day, which would distend the bladder more than usual and perhaps add to its already hypersensitive condition. Such, at any rate, would be a reasonable inference from the history of many of these patients. The first sleep after retiring may extend over some hours, but after being once awakened to empty the bladder the desire is repeated at short intervals until morning.

This does not of course apply to the aggravated and advanced cases, when there is but little rest for the patient day or night.

The amount of residual urine depends largely upon the form of the hypertrophy that is present. It appears sooner or later in all cases, but is found much earlier in those in which the middle lobe principally is enlarged. In these the vesical orifice of the urethra is elevated above the *bas fond*, which, remaining stationary, forms the so-called post-prostatic pouch which the bladder is not able to empty completely. The quantity of residual urine becomes greater and greater as the pouch increases in size, the bladder-walls become dilated, and the power of contraction feeble owing to the great strain made at each act of micturition to overcome the constantly increasing resistance offered by the steady encroachment of the prostatic overgrowth. As the obstruction increases and the strength of the bladder-wall diminishes, the quantity of urine voided at each act becomes smaller and the quantity of residual urine correspondingly greater, until finally, although the individual may be passing urine every hour or two, and, as he believes, emptying the bladder, he may really be carrying as much as from two to four pints. This condition may go on for months if the urine remains sterile. It not infrequently happens that these patients consult the surgeon on account of a supposed abdominal tumor which is found to be the distended bladder: as the patient has been passing urine regularly, he asserts on questioning, and really believes, that there is no trouble of any kind connected with the urinary organs. That which is being passed is, however, merely the overflow—the excess above the capacity of his bladder.

The case is quite different if infection of the urine takes place. The bladder then becomes acutely sensitive to small quantities of urine, which is expelled at frequent intervals, and the result is a contracted bladder. It is for this reason that in the retention due to urethral stricture this chronic form of distention is less frequently observed. In some cases there is acute retention, even going on to rupture of the bladder if unrelieved within a reasonable period, but this is different from the slowly-forming dilatation of the bladder from prostatic obstruction.

Complete retention may be one of the first symptoms to call the attention of the patient to his condition, but more usually this occurs late in the affection. In the former case, with a moderate degree of enlargement, but not sufficient to interfere distinctly with the function of the bladder, the individual is exposed to cold, over-distention from neglecting to urinate at the proper time, sexual excitement, or excess of some kind which tends to increase the amount of blood in the pelvic organs and to induce congestion and swelling of the neck of the bladder sufficiently to obstruct the flow of urine. In the later stages it is due to the obstruction of the urethral outlet by the prostatic overgrowth; it is, however, not complete as a rule, and is gradual in its onset. In the rare cases in which the enlargement of the middle lobe takes the form of a pedunculated growth the tumor may completely obstruct the vesical orifice.

Incontinence of urine is sometimes observed, and may be due to two widely distinct causes. In the first instance, on account of the peculiarity of the prostatic hypertrophy, the vesical sphincter may be so interfered with as no longer to offer any resistance to the escape of urine. In these cases the bladder remains empty or nearly so. This condition is of very rare occurrence, but the possibility should be borne in mind.

Much more frequently the incontinence met with in enlargement of the prostate is the result of over-distention of the bladder, and when the tension becomes great enough to overcome the sphincter, the urine begins to escape, and flows as fast as it comes into the bladder from the kidneys. The amount of distention is, however, not relieved; it is only the excess over and above the vesical capacity that is discharged. This condition, which should be spoken of as "retention with overflow," in contradistinction to true "incontinence," invariably misleads the patient, and occasionally the physician, who, without the knowledge of the facts described, would consider the constant dribbling as evidence of an empty bladder.

Pain is an inconstant symptom. In the milder cases it is usually absent, or there may be indefinite pains in the groins, testicles, and thighs, or a sense of fulness may be felt in the rectum or perineum. In the later stages more or less distressing pain arises from the inflamed condition of the bladder. Either a distended bladder or cystitis will cause a constant distress behind the pubes, which becomes very trying to the endurance of the patient. There may be a soreness or smarting felt in the urethra, and shooting pains may extend to the glans similar to those felt in cases of vesical calculus. The severe straining efforts to pass water and the irritation of the rectum due to the presence of the enlarged gland cause tenesmus, prolapsus ani, or hemorrhoidal swellings more or less frequently. During the efforts to evacuate the bladder the contents of the bowel frequently escape from the inability of the patient to control the anal sphincter during micturition.

The periodical appearance of hematuria is common in the later stages of prostatic hypertrophy. If not too profuse, it relieves congestion, and thus to a certain extent lessens the distress of the patient. It is apt to occur after exposure or other influences which cause congestion of the pelvic organs. It may also result from efforts to catheterize the bladder, in which case it is sometimes exceedingly profuse. If the bladder becomes infected, as is apt to occur particularly in the cases that require frequent catheterization, the symptoms described have superadded to them those of severe cystitis. The patient is tormented with almost constant desire to urinate, which, however, does not relieve the distress, or at most for a brief period, the act itself being accompanied with great pain and tenesmus, or, if there is complete obstruction, the catheter will have to be passed at short intervals, and the introduction of the instrument is attended with acute suffering.

The constitution sooner or later shows the debilitating effect of pain and loss of rest. The patient loses weight, the strength fails, his appetite is impaired; he becomes cachectic and ages rapidly. There is apt to be some febrile movement; the tongue is coated and the pulse rapid. Slight exposure or other irregularities are apt to produce marked exaggeration of the symptoms, during which retention is threatened or actually occurs. The long-continued intravesical tension sooner or later results in dilatation of the ureters and backward pressure upon the kidneys, which become greatly embarrassed in their function. If the urine has been infected, the kidneys will become similarly involved, still further crippling their secreting power. As a consequence, many of these patients are in a condition of greater or less uremic intoxication, and succumb if the slightest additional strain is added. It is this fact that makes the surgeon hesitate to perform any operation upon these patients, the mildest operative attack, or even the mere administration of ether, is so apt entirely to disable the already greatly crippled kidneys.

So long as the urine remains uninfected there are no decided changes in its composition. The specific gravity is perhaps a little below the normal average, and is due to a corresponding increase in the amount. This probably results from the fibroid condition of the kidneys common to advanced years, but intensified by the passive hyperemia brought about by reflex irritation from the neck of the bladder. Tube-casts are absent unless the kidneys were previously diseased or unless an infectious inflammation of the kidneys developed subsequent to cystitis. When the latter disease becomes established the urine is intensely foul from decomposition—is loaded with pus and mucus, and possibly with blood. The mucous membrane becomes intensely injected, and may be ulcerated in places.

The condition of the urine just described is favorable to the formation of vesical calculi, especially of the phosphatic variety, and, in fact, stone in the bladder is a not infrequent accompaniment of prostatic hypertrophy. The presence of stone may be suspected if there is frequently a sudden stoppage in the flow of urine, or if there is great pain at the neck of the bladder or in the glans penis at the end of urination, and if the blood and pus are pretty constantly present and are greater than the degree of the prostatic disease would seem to account for. In any case in which it was suspected it would be proper to relieve any doubt by the careful use of the vesical sound.

The irritation of the enlarged prostate in some cases is attended with more or less erethism, or perhaps even erections or priapism. In other cases a painful orchitis develops. If the prostate has been injured by the introduction of instruments, an abscess may form, and this may be followed by septicemia or pyemia.

If the prostatic enlargement is pronounced, the patient will complain of symptoms referable to the rectum. In addition to a feeling of fulness or a sensation as though a foreign body was present, there may be some obstruction to the discharge of feces, and such patients may be obliged to take laxatives habitually in order to keep the contents of the bowels in a soluble condition to facilitate the movement.

Dr. A. Guépin [1] of Paris calls attention to two sources of orchitis in these cases—first: the use of the catheter; second: the lessened resistance of the senile prostatic tissue with the infectious material so near at hand—in the distended bladder usually the seat of inflammation.

When true orchitis does not develop in such cases, there often exists an abnormal tenderness of the testicle. This increases whenever the general health runs down or when the venous congestion and prostatic irritation due to constipation are allowed to go on for any length of time. Sometimes the progress of the chronic infection along the cord can be noted in the progressive advance of the tenderness and swelling. These reach the epididymis and testicle, affecting both structures about equally in from two to four days. An effusion of serum into the tunica vaginalis may follow, and this may even become purulent. The whole process is characterized by the slow and progressive course of the swelling, by the usually moderate pain, and occasionally by localized suppuration.

Diagnosis.—There should be no difficulty in arriving at a diagnosis in the majority of cases. The symptoms already detailed are fairly characteristic, and when they are observed in a patient in or beyond the fiftieth year we should at least think of prostatic hypertrophy as the condition most likely to be present. The final conclusion will rest, however, upon the evidence obtained by the urethral and rectal examinations. The condition must be distinguished from other forms of obstruction and from atony and paralysis of the bladder.

Stricture of the urethra gives rise to symptoms somewhat similar to those of prostatic enlargement, and will more frequently have to be differentiated from the latter than any other condition. There would be increased frequency of urination, attended with more or less difficulty, and there might be a small amount of residual urine or even overflow. A correct conclusion would result from a consideration of the following points: If stricture was present, there would be a history of a previous urethritis or rupture of the urethra from some violent force being received on the perineum. The frequency of urination would be diminished during repose, and increased effort would usually aid, and not retard, the stream, as it frequently does in prostatic hypertrophy. Finally, an examination of the urethra with bulbous bougies will remove any doubt. If an instrument of proper size for the given urethra meets with an obstruction within the first six inches from the meatus, the presence of stricture is certain.

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[1] *La Tribune médicale*, Feb. 26, 1896.

A vesical calculus may give rise to conditions simulating those of enlarged prostate. The distinctive features of the presence of a calculus, as far as such may be stated, are—severe pain felt in the glans penis, especially at the end of micturition; the exacerbation of the symptoms, especially of pain and of bleeding after vigorous exercise, and the amelioration of the symptoms and the distinct diminution in the frequency of urination brought about by rest. Some of the symptoms might belong equally well to either condition, and the occasional association of the two in the same case must not be forgotten. The use of the sound will almost invariably remove any doubt.

The presence of vesical tumors or tuberculosis is more difficult to determine. The cystoscope will help us in many cases. In others the constant and profuse hematuria, the more marked pain, and the more rapid course would lead us to expect tumor or tuberculosis. In the case of villous tumors fragments may sometimes be detected in the urine. Although primary tuberculosis of the genito-urinary tract may occasionally occur, it is much more frequently found associated with tubercular disease of some other organ.

Atony of the bladder may follow a single or repeated voluntary prolonged retention. It occasionally happens that no opportunity is offered for voiding urine for a long period. The condition which results is not unlike that produced by retention from enlarged prostate, and requires the use of the catheter at least immediately and perhaps for some days. The history of the attack and the absence of symptoms will lead the surgeon to the correct interpretation of the case. It will be observed in atony of the bladder that the urine flows from the catheter without any force, and voluntary effort has little or no effect on the stream.

Paralysis of the bladder results from disease or injury of the spinal cord, and is constantly associated with a similar condition in the lower extremities or other parts. The term "paralysis" should not be applied to conditions causing obstruction at the neck of the bladder or to over-stretching of the vesical muscle (atony).

The existence of cystitis will depend upon the presence of some other condition, which must be sought for. It is caused by strictures, posterior urethritis, certain drugs, traumatism, vesical calculus, tumors, tuberculosis, etc.

The recognition of prostatic hypertrophy depends, as has already been stated, upon the careful instrumental examination of the urethra and digital examination through the rectum. The examination of the urethra should be conducted somewhat as follows: A full-sized metal catheter, properly sterilized and lubricated, is passed gently into the urethra, which may previously have been irrigated in order to avoid carrying into the bladder any germs that may be present. If the catheter passes without obstruction, and particularly if urine begins to flow when the eye is from seven to seven and a half inches from the external meatus, we may be sure that marked enlargement does not exist. On the other hand, if the catheter does not withdraw urine until eight, nine, or even more inches have been passed, and if, in addition, it is necessary to depress the shaft of the instrument more than usual between the patient's thighs, the presence of prostatic hypertrophy may very properly be suspected. In some cases after passing the silver catheter to its full length it would still fail to draw urine. In such an event it is proper to next try what is known as the "prostatic catheter," which has a longer and larger curve and a longer shaft. The larger curve is for the purpose of riding over the prominence of the floor of the prostatic urethra caused by the overgrowth, and the increased length of the shaft is to meet the lengthened urethra that occurs in hypertrophy of the prostate. If this instrument passes readily, we can ascertain the length of the urethra and the direction of its prostatic portion. In some cases as the beak traverses this part of the urethra the handle will be deflected to the right or left, which indicates either a greater degree of enlargement of one lateral lobe than of the other or marked hypertrophy of the median portion. If a soft-rubber catheter is used, we may measure the length of the urethra by carefully marking on the catheter the position of the external meatus at the moment urine begins to flow. The distance from this point to the middle of the eye of the catheter will indicate the length of the urethra. In cases in which there is considerable upward projection none of the instruments mentioned can be passed, and it will be necessary to employ the elbowed catheter of Mercier, the double-elbowed catheter, or one with a very large curve, according to the character of the obstruction in the individual case. It is desirable to use a fairly large-sized instrument whenever possible.

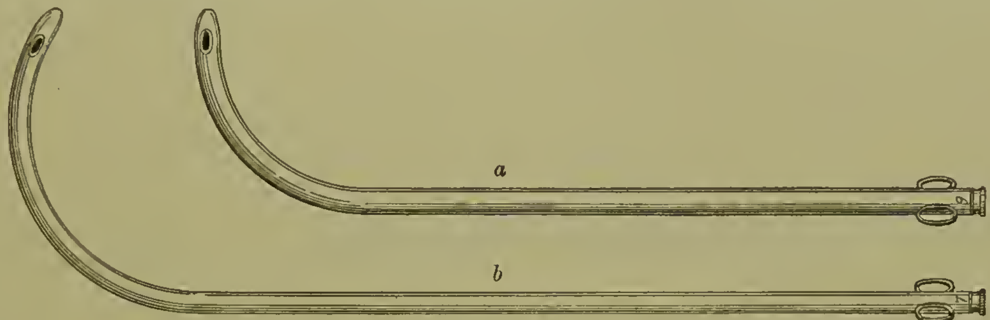

FIG. 78.—Metal catheters: *a*, usual form; *b*, prostatic catheter.

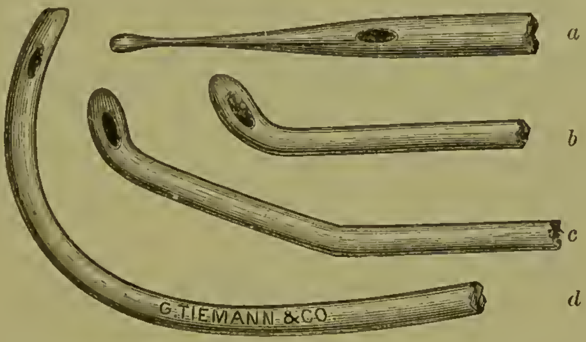

FIG. 79.—*a*, French olivary catheter; *b*, Mercier's elbowed catheter; *c*, Mercier's double-elbowed catheter; *d*, curved woven catheter.

Considerable information is to be obtained by rectal examination. As in the preceding manipulations, the patient should lie upon his back. It is most convenient to employ the middle finger of the left hand for this examination. After having filled the spaces around and beneath the nail with soap, the finger is oiled and introduced into the rectum. By sweeping the finger from side to side over the gland and from before backward, it is possible to determine in the first instance whether the gland is enlarged, and if so the extent of the increase in size and whether it is partial or general. During the examination the right hand may be used to forcibly depress the hypogastrium. We may also determine the degree of tenderness present. If a solid instrument be allowed to remain in the urethra during this examination, the examining finger is enabled to determine more accurately the precise size and conditions of the prostate, especially its thickness from the urethra to the rectal wall. It will be remembered that the normal gland is but slightly larger than a horse chestnut. The enlargement, as felt by the rectum, may be moderate or very great, in some cases resembling in size an orange or even a cocoanut. We should also at this examination endeavor to determine (1) the predominant character of the growth, whether soft, indicating excess of glandular and muscular elements, or hard, showing advanced fibroid change; (2) the seat of the growth, which is of interest in relation to the change in the bladder. It may be said that when the enlargement affects the lateral lobes chiefly, the urethra is narrowed and compressed. In such a case the difficulty in urination depends on purely obstructive causes which are quite outside of the bladder. This organ undergoes in consequence the usual hypertrophy and thickening of its muscular walls, with diminution of the size of its cavity. There is little residual urine. If the growth is median, projecting backward into and beneath the neck of the bladder, or if the lateral lobes are elongated in the same direction, a dam is formed behind which residual urine is retained. The muscular tissue at the base of the bladder, which is prevented from contracting normally, atrophies and becomes thin; the post-prostatic pouch gradually increases in size. As a rule, vesical atony supervenes, and the expulsive power becomes very feeble or is completely lost, so that in neglected cases the urine which escapes from the bladder is simply the "overflow." (3) The presence of general sclerosis with rigid vessels, arcus senilis, polyuria, hyaline casts, etc., and with rigidity of the bladder-walls, will usually be associated with a dense fibroid condition of the prostate. (4) Infection of the bladder with pyogenic organisms materially modifies the case both in regard to the prognosis and the treatment.

It is desirable in every case to estimate the amount of residual urine. This is done by introducing a catheter after the patient has emptied his bladder to the best of his ability. In the presence of over-distention but a portion of the urine should be removed at one time. Failure to observe this precaution may result in considerable shock to the patient, which may be followed by suppression of urine, uremia, and death. The sudden withdrawal of the pre-existing intravesical tension so weakens the mucous membrane that it is very susceptible to microbic infection, and fatal cases of cystitis have frequently followed in this way. The strength of the muscular coat can best be determined by watching the force with which the urine escapes from the catheter. The character of the urine should also be taken into account. If it is alkaline and offensive, with a heavy deposit of pus, mucus, and phosphates, it is evidence of a very severe infection of the bladder-wall. The condition of the kidneys should also be determined as accurately as possible.

In some of these cases the cystoscope may be employed to advantage in determining the exact size and position of the enlargement. Usually, however, but little information can be obtained with this instrument. It is almost useless in cases in which hemorrhage is easily excited, because the fluid so soon becomes opaque that the field of vision is entirely obscured.

Treatment.—The treatment of prostatic hypertrophy may be (1) expectant, (2) hygienic, (3) medicinal, (4) palliative, and (5) operative.

(1) The purely expectant plan is applicable only to those cases in which enlargement has produced no symptoms and catheterism is easy and shows no residual urine. Such cases will include those in which the prostatic condition is recognized during an examination instituted for other reasons. They are not infrequently met with in practice, and have been observed before the fortieth year of life. An antecedent history of posterior urethritis should of course suggest a possibility of chronic prostatitis, which may be recognized by the symptoms mentioned under this heading.

(2) The hygienic treatment of this condition is likewise applicable to but the mildest forms of the affection. It is of the first importance to maintain all of the functions in a healthy condition, as any irregularity may bring about increased irritability of the bladder and more pronounced obstruction. In the matter of diet the patient should confine himself to what would be included under "plain but nutritious" food. Idiosyncrasies must be respected. In general, broiled steaks and chops, poultry, game and fish, well-cooked vegetables, or fruits (excluding the very acid varieties), stale bread, fresh milk, eggs, farinaceous foods, etc., are allowable. Pork, salted and dried meats, highly-seasoned dishes, rich soups, pastry, cheese, and the richer kinds of dessert, strong tea or coffee, pickles, mustard, condiments generally, all unripe and many uncooked fruits and vegetables, are to be rigorously avoided. The question of alcoholic beverages is to a certain extent an individual one. Any excess is certainly deleterious. In cases of more or less pronounced debility a dry sherry or claret or small quantities of whiskey or brandy may be used to advantage. It is needless to say that if cystitis should supervene these should be withdrawn for a time at least. Constipation should be carefully avoided by care in diet, by exercise in moderation, by regularity in the habits, and by gentle laxatives when necessary, the particular kind of which may be varied from time to time with advantage. The clothing should be such as to protect the surface from sudden changes of temperature. An entire suit of woollen underwear is desirable. Any chill of the surface is apt to be felt at once in the increased frequency and difficulty of urination. Dampness is to be carefully avoided. Considerable protection and comfort is afforded by wearing a heavy woollen bandage around the loins. Regular tepid baths are to be advised to promote the healthy function of the skin.

It is important for the patient to take regular exercise in moderation. No form is more useful than walking. Riding may be injurious. Driving over good roads is unobjectionable. Fatigue should be avoided. Some form of mental occupation is desirable to keep the patient from dwelling unnecessarily upon his condition and believing himself a confirmed invalid.

Moderation in all things should be the watchword. Sexual excitement is harmful, and it may be necessary in certain cases to advise against intercourse.

(3) The medicinal treatment of prostatic hypertrophy, so far, has been disappointing. The only drug that seems to have a direct influence upon the enlargement is ergot, which is administered on the theory that the prostatic overgrowth is analogous to the fibro-myomata of the uterus, and would be

influenced in the same way by this drug. To be of benefit it must be exhibited for a long period. In some instances it seems to disagree with the stomach, which will make necessary the reduction in the dose or even its complete discontinuance. It will be most beneficial in the cases in which the hypertrophy of the muscular and glandular elements predominates, as evidenced by the softness of the gland. It must always be combined with other measures, either general or special, according to the indications of the particular case. If the urine is unhealthy, the administration of salol or boric acid will be useful; for vesical irritation small doses of belladonna and the bromides will be of service. For loss of tone of the muscular wall of the bladder strychnine or nux vomica will be useful. If the urine is distinctly alkaline, the administration of boric acid or of benzoic acid is indicated. On the other hand, excess of acidity should be met by care in the diet, by suitable laxatives, and by the administration of piperazin, of which five grains may be given three times a day. If these fail, one of the salts of lithium or potassium may be administered. For catarrh of the mucous membrane of the urinary tract sandalwood oil or oil of eucalyptus may be administered with benefit. The further exhibition of drugs would be to meet the special complications present, and they would be given on the general principles governing the treatment of such affections from whatever cause.

(4) Palliative treatment consists in the use of steel sounds of full size or other instruments to maintain the patency of the prostatic urethra, and the systematic use of the catheter. Dilatation will be beneficial chiefly in those cases of incipient hypertrophy in which urination is not of great frequency and the amount of residual urine is small, and if in addition the enlargement as felt through the rectum is of moderate density and offers but slight resistance to the introduction of an ordinary catheter. It is a good custom to pass the largest steel sound that the membranous urethra will comfortably accommodate every fifth to seventh day, allowing the instrument to remain from five to fifteen minutes. In this way the caliber of the urethra is maintained; whether the simple stretching causes a slight resorption of the parts immediately surrounding the canal or a dissipation of local congestion and tumefaction, the discharge of urine is facilitated, and consequently the vesical irritability and the quantity of residual urine are both diminished. It is necessary to observe the most rigid asepsis in order to guard against the occurrence of cystitis. This method has been strongly advocated by Harrison,[1] who uses flexible instruments with an enlargement near the vesical end (Fig. 80). Intelligent patients learn to pass these instruments for themselves, and if sufficiently impressed with the necessity for gentleness and clean-

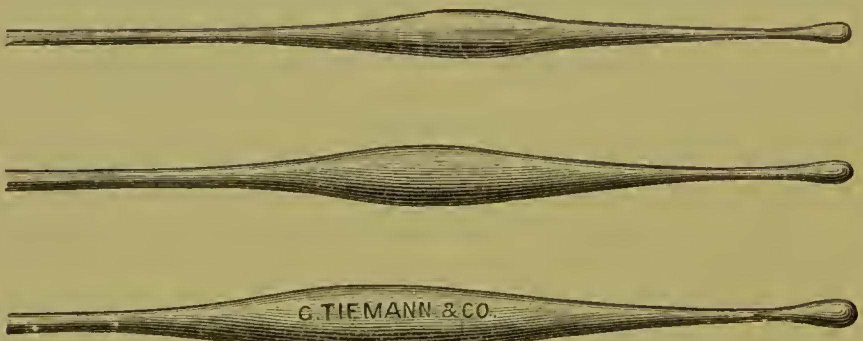

FIG. 80.—Harrison's prostatic dilators.

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[1] *Brit. Med. Journ.*, 1882.

liness, no harm will likely result. It is not to be supposed that this treatment will have any curative power or that it will arrest the progressive enlargement of the gland, but it delays the consequences of the hypertrophy for a considerable time at least.

If the quantity of residual urine amounts to two ounces or more, it is desirable to institute systematic catheterization. Some form of soft instrument of medium size will be found to be most suitable. The choice will be made by learning which particular form can be passed most easily and with the least discomfort to the patient. As a general rule, the catheter should be passed once daily if the residual urine amounts to between two and four ounces, twice daily for six ounces, and once more for every additional two ounces. A proper appreciation of the dangers attending the withdrawal of the residual urine will go far toward obviating their occurrence. The danger of causing cystitis is an ever-present one, and will be surely avoided only by the most careful asepsis. The sudden withdrawal of a large quantity of retained urine may be followed by immediate syncope or later by "catheter fever." The latter is usually announced at the first act of micturition after the instrumentation by a chill, when the patient is found to have fever, a rapid pulse, and considerable prostration. In marked cases the fever rises very high, sometimes reaching 106°, and subsides by crisis, which is accompanied by a profuse sweat; the typhoid condition may be observed early in the course of the case. In its milder forms the symptoms are all moderate and pass off with the first crisis or during the next two or three days. The condition is always serious if the patient's kidneys have become affected by the long-standing bladder trouble. Syncope will be avoided by withdrawing but a portion of the urine when there is a large quantity present, and the danger of catheter fever will most likely be obviated by observing the strictest cleanliness. While the etiology of the latter is not known, the condition is probably caused by a more or less pronounced sapremia or septicemia resulting from the slight traumatism of the urinary canal caused by the instrumentation.

If cystitis is present, the bladder should be irrigated with warm solution of boric acid 1 : 50, bichloride of mercury 1 : 20,000, silver nitrate 1 : 5000, or potassium permanganate 1 : 5000, each time that the catheter is introduced, or one to four times daily, depending upon the case. In the milder forms of the disease the boric-acid solution is preferable. In the presence of marked infection with purulent and ammoniacal urine the stronger antiseptics will be more serviceable. In the cases complicated by marked cystitis Guyon and Michon[1] have employed the retained catheter in a large number of cases. At the time of undergoing the treatment the patients were suffering from an acute attack superadded to a chronic cystitis. In 38 of the 49 cases reported (77 per cent.) a cure is said to have been obtained without any complication. In 11 cases the symptoms persisted. In the former defervescence was observed from the first to the sixth day, most often on the third day. The retained catheter was also employed in cases of hemorrhage following the use of instruments, and always with the greatest benefit. For the success of this treatment it is essential that the catheter should be introduced exactly the proper distance and accurately retained in this position. The underlying principle is that of drainage and physiological rest, and to secure these ends the urine must flow from the catheter as fast as it enters the bladder from the kidneys. If the pain and fever continue, it will probably be found that the catheter is too far within the bladder.

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[1] *Ann. des Mal. des Org. Gén.-urin.*, May, 1895.

If these measures are properly carried out, the patient with hypertrophy of the prostate and with more or less retention may pass through a number of years in comparative comfort.

It has been urged that the regular use of the catheter will conduce to vesical atony, and this must be borne in mind when the practice is instituted, but it is not a valid argument against its use in proper cases.

If a patient suffers from complete retention from the effect of exposure or other cause, he should be put to bed, covered warmly with blankets, and should be surrounded by hot-water bottles, especially about the pelvis and the lower extremities. If convenient, a hot sitz-bath may be given. The lower bowel should be emptied by an enema, and, if required to relieve pain or spasm, a suppository of opium may be administered. If these measures fail to re-establish the flow, it will become necessary to withdraw the urine by means of a catheter. The soft instruments are preferable if they can be made to enter the bladder; if not, a full-sized silver prostatic catheter must be employed. The utmost gentleness must be observed in their introduction, and the remarks already made in regard to asepsis and the dangers of drawing off all of the urine at once must be borne in mind.

In his desire to relieve a patient suffering from retention the physician may be led to employ more force than is proper when using metal instruments, and produce a false passage, which adds greatly to the gravity of the condition. Patience will invariably accomplish more with less risk than will force. In case it is impossible to pass any instrument into the bladder, it will become necessary to perform suprapubic aspiration of the bladder, the puncture being made about an inch above the symphysis pubis. In the course of a few hours it may be possible to introduce the catheter, when the usual precaution against withdrawing too much at one sitting must be observed. In case it is impossible to introduce any form of catheter by the second day, one of the operations to be mentioned later should be performed rather than continue the repeated aspirations.

Unfortunately, in spite of the most intelligent and careful treatment of these cases, a time will come in many cases when instrumentation is so difficult and painful that some further relief becomes imperative, and the degree of cystitis present may also call for some more radical method of treatment.

(5) **Operative Treatment.**—It too frequently happens that when the patients come under the observation of the surgeon the golden opportunity for permanent relief has passed by. This will certainly be the case if cystitis and infection of the kidneys have occurred. It seems proper, however, to give the patient the benefit of the chance for possible relief from what frequently is agonizing suffering.

Among the means that have been advised for the advanced stages of enlargement of the prostate are—(1) electricity, (2) massage, (3) overstretching the prostatic urethra, (4) perineal drainage, (5) suprapubic drainage, (6) prostatotomy, (7) prostatectomy, of which there are several forms, (8) castration, (9) excision of the vas deferens, (10) ligation of the vascular constituents of the cord, (11) ligation or section of the entire cord.

Electricity.—A number of writers have employed electro-puncture, introducing the needle attached to the negative pole into the prostate through the rectum. Among these may be mentioned Biedert,[1] Casper,[2] and Roux.[3] Biedert noted marked improvement in 1 case out of 5. Casper reported that of 4 patients treated in this manner 2 were cured, but in 1 a rectal fistula remained. In 4 of Roux's patients the gland was said to have diminished in size.

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[1] *Deut. med. Woch.*, 1888.

[2] *Berl. klin. Woch.*, 1888.

[3] *Société vaudoise de Médecine*, 1888.

Bottini[1] advised the use of the galvano-cautery for the purpose of removing the prostatic obstruction. The electrode, which has a short beak placed at an angle to the shaft, resembling in shape a Mercier catheter, is introduced into the bladder, the point turned downward, and the instrument withdrawn until it comes into contact with the obstruction. The current is then turned on, while some pressure is made against the obstruction. If there is any doubt about the location of the point of the instrument, a rectal examination should be made. During the time that the current is on a stream of water circulates through the catheter in order to prevent it from becoming overheated. The instrument is to be pushed in the bladder and allowed to cool before being withdrawn. Bottini has operated on 77 cases in this way: 52 are said to have been completely cured; in 11 there was some improvement; in 12 no result was obtained; 2 died, both of these being among the first so treated. Bruce Clark[2] recommends the use of the galvano-cautery by Bottini's method. Of 4 cases so treated, 3 were said to be absolutely cured three to six months after the treatment. Newman[3] also advocates the application of the galvano-cautery to the prostatic urethra. Watson has also devised an instrument to be used in the same manner.

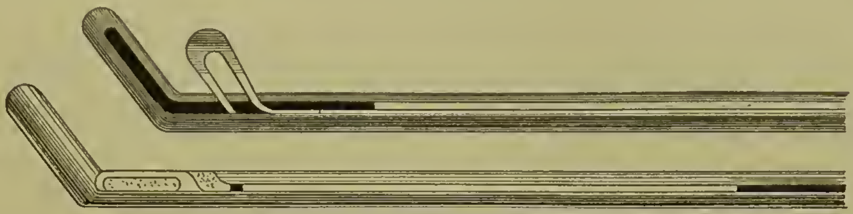

FIG. 81.—Bottini's galvanic prostatome.

The methods here described do not seem to have been used to any extent. The electro-puncture, like the parenchymatous injections of various chemicals, is attended with many disadvantages. Although in some instances temporary reduction in the size of the prostate has been noted, there is a probability that the treatment will increase the congestion and swelling of the prostate, and may lead even to the formation of abscesses. The procedure recommended by Bottini is rather more rational, but is performed entirely in the dark; it would be suitable only for cases in which there is a projection in the floor of the urethra. In the present state of our knowledge the method is not to be recommended. The same remark might be applied to the other methods of applying electricity which have been advocated.

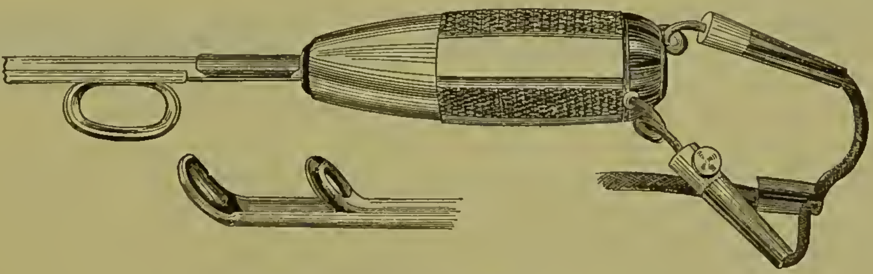

FIG. 82.—Watson's galvano-cautery prostatectatome.

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[1] *Centralb. f. Chir.*, 1885.

[2] *Lancet*, London, 1892.

[3] *British Med. Journ.*, 1887.

Massage.—Ebermann[1] recommends the use of massage in the following manner: The patient is placed on the back or in the knee-elbow position. The masseur introduces the finger into the rectum and rubs the gland from left to right and *vice versâ*, making pressure in the direction of the symphysis. A bougie may be introduced into the urethra. The séances, which should last from five to ten minutes or more, may be repeated every day or every second day. At the same time hot sitz-baths and a suppository of three to five grains of the iodide or bromide of potassium are recommended. It is claimed that in this way the pathological products are removed through the veins and lymph-channels. Güterbock recommends massage in the softer forms of hypertrophy when the whole gland is of the same consistence. He says that the hard myomatous growths could scarcely be influenced, although no harm would follow the procedure. Enlargement of the middle lobe is not susceptible to this method of treatment, as it grows upward into the bladder and beyond the reach of the finger.

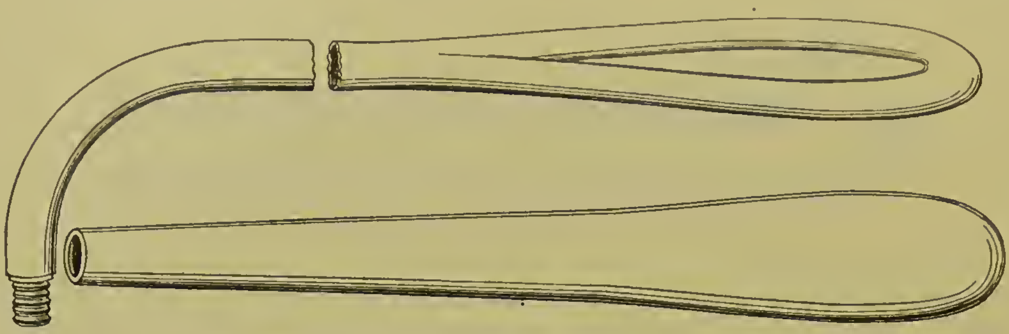

FIG. 83.—Instrument for massage of the prostate (Feleki).

Feleki[2] describes an instrument which he has had made for the purpose of applying massage to the prostate in cases of chronic inflammation. The instrument is made with a handle 20 cm. long, attached at the extremity to a pear-shaped body 13 cm. long and 6 cm. in circumference. Swinburne[3] has modified the instrument devised by Feleki (see Fig. 84).

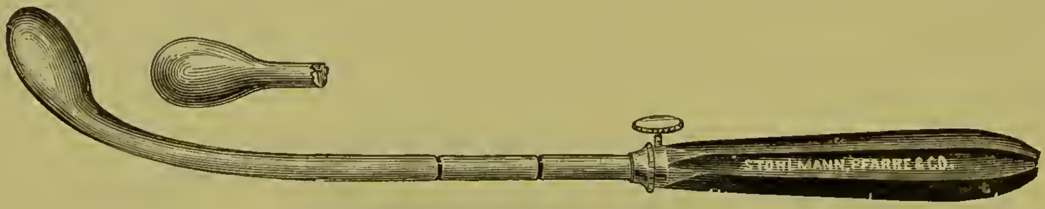

FIG. 84.—Swinburne's instrument for massage of the prostate.

Overstretching the Prostatic Urethra.—Early in the present century Physick suggested the use of hydraulic compression, for which he invented a special instrument, and Sir Henry Thompson devised what he called a hydrostatic dilator some forty years ago. No one seems to have adopted the method suggested by Physick, and Thompson later discarded the use of his dilator. Upon this subject he remarks that no one of experience would now venture to use instruments large enough to produce any diminution of the gland or any dilatation of the canal which passes through it by the agency of compression, on account of the probability of exciting prostato-cystitis; and he does not believe that any beneficial effect on the gland is possible by this agency. Thompson's estimate of this operation was formed before the antiseptic methods were known, and it is quite possible that the risk of prostato-cystitis would be very much less if the procedure was carried out with rigid asepsis. Overstretching could scarcely be beneficial in the cases in which the enlargement affects chiefly the "middle lobe" or the vesical neck. In the cases of lateral hypertrophy in which the urethra is compressed between the two enlarged lobes, or is rendered tortuous by irregular hypertrophy, the method might be found beneficial. To secure the best effects the procedure should be carried out under general anesthesia, and the stretching should be pushed as far as the safety of the patient will admit.

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[1] *Intern. Centralb. f. d. Physiol. u. Path. d. Harn. u. Sex.-org.*, Leipzig, 1891–92.
[2] *Centralbl. f. d. Krankh. d. Harn. u. Sex.-org.*, 1895, Nos. 9 and 10.
[3] *American Medico-Surgical Bulletin*, March 28, 1896.

The effect of stricture of the urethra in causing atrophy of the prostate is explained by Thompson as a result of pressure. In further confirmation of these observations may be cited the experience with the use of the steel sounds in the milder forms of enlargement of the prostate to which reference has been made, and which has given in many cases the greatest satisfaction. Belfield has suggested dilatation of the prostatic urethra through a perineal incision, but the operation has not been employed in a sufficient number of cases to justify an opinion regarding its value. Bangs suggested digital dilatation by means of a suprapubic opening, and employed it frequently, but recontraction speedily followed.

The theoretical advantage of a hydrostatic dilator would be the uniform pressure exerted on the whole circumference of the prostatic urethra and vesical neck, with less risk of dangerous laceration of the mucous membrane than by using the metal dilators.

The method may be proposed, tentatively or experimentally, in the cases of hypertrophy of the lateral lobes in which the palliative treatment has failed to give relief and more radical measures are declined.

Perineal Drainage.—In cases of enlarged prostate complicated by the presence of a high degree of cystitis, demanding the introduction of the catheter every hour or even more frequently, the introduction of which is attended with great difficulty and with intense pain, some form of relief by a more radical method becomes imperative. Heretofore, this has been drainage of the bladder, either alone or combined with one of the forms of prostatectomy. The operation of castration is likely to supplant that of simple drainage of the bladder in the vast majority of cases, but the latter will be described for those cases that refuse the former procedure, and the now comparatively few cases in which for other reasons it may be especially indicated.

The perineal route is by all odds the simplest way of establishing permanent drainage of the bladder if it cannot be secured by a catheter introduced through the urethra. Thompson recommends a median incision after the introduction of a grooved staff. The urethra is opened immediately in advance of the prostate, and a catheter introduced into the bladder. The catheter is removed after some days, depending upon the degree of relief which has been obtained.

Annandale[1] has modified the foregoing procedure by establishing permanent drainage. A large-sized india-rubber tube is secured in the wound by means of silk threads; to this may be attached another piece of tubing of convenient length, which may be closed by a pinch-cock, the latter being removed when it is desired to empty the bladder.

Whitehead[2] also favors a permanent perineal opening for those cases that have reached the stage when all prospect of their ever again being able to pass urine in the natural manner has been abandoned as hopeless.

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[1] *Edin. Med. Journ.*, vol. xxxiii.

[2] *Proceedings of the Royal Med. Society*, vol. xii.

In 1881, Harrison punctured the bladder from the perineum in the case of a man aged eighty-four years who was much reduced by advanced prostatic disease. The operation, which he calls "tunnelling the prostate," is performed as follows: A suitable trocar and cannula (Fig. 85) is selected, and entered in the middle line of the perineum one inch in front of the anus and in a direction toward the umbilicus. The instrument is so constructed that urine flows as soon as the bladder is entered, when the trocar is withdrawn, the cannula being allowed to remain. The patient referred to was up in twenty-four hours. In about six weeks urine began to pass by the urethra and the cannula was removed. Two years later the prostate could not be felt. The man died at the age of ninety without having had any recurrence of the disease.[1] Similar shrinkage and improvement have been observed after cystotomy for stone or other cause when the enlarged prostate has been divided.

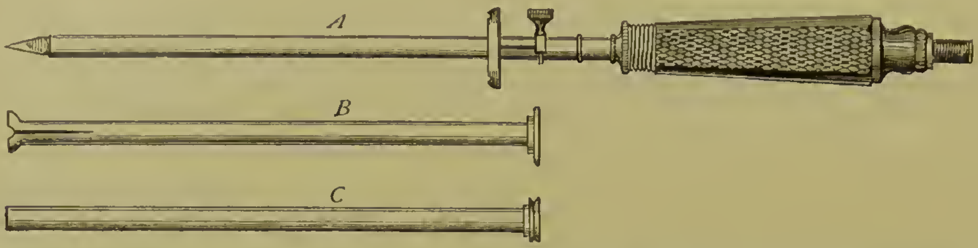

FIG. 85.—*A*, trocar with cannula complete; a piece of india-rubber tubing is to be attached below the collar of the cannula on withdrawal of the trocar, to convey the urine into a receptacle; *B*, silver cannula, which is introduced in tube of *A* to form a probe-end, and for retaining it; *C*, a plain silver tube with which to clear *B* in case of its becoming blocked up (R. Harrison).

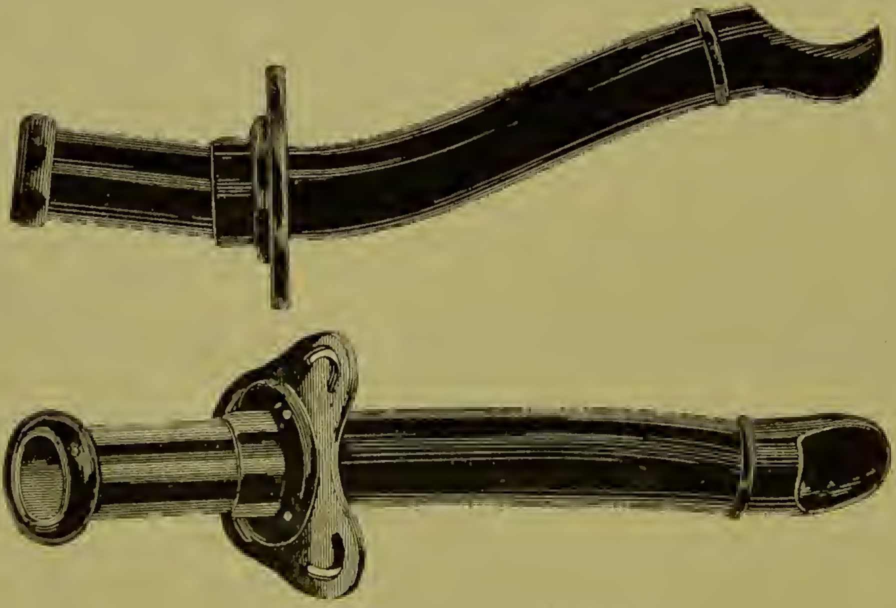

FIG. 86.—Perineal drainage-tubes (Watson).

Tunnelling the prostate is not as safe a procedure as the method by incision, and is not to be recommended. Where the sole object is to secure thorough drainage of the bladder with the least risk to the patient, a median perineal cystotomy will be the operation of choice.

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[1] *Surgical Disorders of the Urinary Organs*, 3d ed.

Suprapubic Drainage.—Suprapubic cystotomy for the purpose of securing permanent drainage in cases of prostatic hypertrophy was first performed by Thompson in 1869. In this country Hunter McGuire has suggested the formation of a permanent artificial urethra above the pubes. He performs the usual operation, and after the wound heals sufficiently introduces a catheter of special design with a stopper, which is worn permanently by the patient.

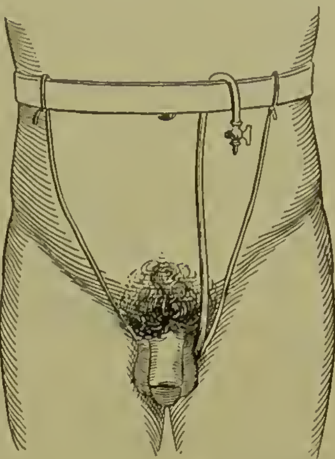

FIG. 87.—Apparatus for drainage of bladder (R. Harrison).

This operation permits of digital or even ocular exploration of the interior of the bladder, and in rare instances one is able to deal with pedunculated growths without adding much to the danger already incurred. Calculi, if present, may be removed. Morris[1] has modified this operation by transplanting flaps of skin from the sides of the abdominal incision so as to form the new urethra. He attempted in this way to overcome the tendency to contraction that otherwise follows healing.

The operation of suprapubic cystotomy is one that requires considerable time; it may be attended with difficulty if the bladder is contracted and a rather prolonged anesthesia is necessary; all of which are very objectionable, and frequently positively contraindicated in the very patients who are most in need of relief. The danger of opening the peritoneum in these cases is by no means fanciful.

As was mentioned under the previous heading, castration or one of its substitutes is likely to restrict very much the indications for the suprapubic operation.

Prostatotomy.—The division of the bar at the neck of the bladder, either by cutting instruments (Mercier) or by the use of the cautery (Bottini) introduced through the urethra, is mentioned only for the purpose of condemning it. This procedure was adopted with the view that the obstruction is always a bar at the neck of the bladder. Not only is this conception incorrect, but if it were not these procedures are so clumsy and uncertain that their employment could not be recommended. If in rare cases there is any distinct indication for such a procedure, the operation could be better accomplished through a perineal incision.

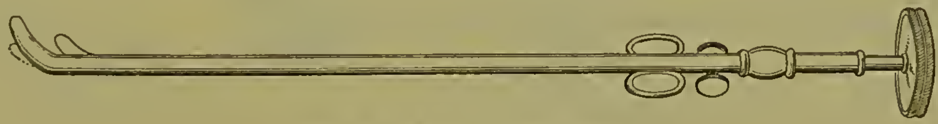

FIG. 88.—Mercier's prostatome.

Perineal prostatotomy in its simplest form consists in opening the urethra at the apex of the prostate by a median incision, and dividing the obstructing portion of the gland by means of a probe-pointed bistoury cutting from within outward. The channel may be further enlarged by divulsion by the finger.

At the meeting of the International Medical Congress in Copenhagen in 1884, Harrison described a method of dealing with the retention of urine from enlargement of the prostate,[2] which is as follows: The membranous urethra is opened on a grooved median staff, when one of the following procedures is carried out: (1) The prostatic bar is divided on the floor of the gland; (2) some portion of the prostatic ring or outgrowth is removed or enucleated; (3) the prostatic ring or outgrowth is forcibly stretched by the finger or a suitable sound. The introduction and retention of a suitable drainage-tube should invariably follow, irrespective of which method is adopted. Of 36 cases of advanced prostatic obstruction in persons over sixty years of age so treated, the floor of the prostate was divided or a portion of the gland removed in 18 cases, whilst in the remaining 18 simple drainage was secured. Harrison was able to satisfy himself that in 10 of these the function of urination had been restored.

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[1] *N. Y. Med. Journ.*, July, 1890.

[2] *Brit. Med. Journ.*, 1893, i. p. 512.

This operation will be indicated in certain cases that refuse castration in which there is marked diminution of expulsive force, cystitis, and evidences of widespread degenerative changes or of distinct renal disease, accompanied by toxemia and general feebleness. It will also be appropriate in some cases in which the bladder is rigid and contracted, holding but a few ounces of urine, or if the atony is nearly absolute and does not tend to improve under careful treatment, although renal and constitutional symptoms are absent.

The beneficial results are probably due to a combination of mechanical dilatation of the channel and cicatricial contraction of the substance of the gland, reducing its bulk in the immediate vicinity of the urethra and consequently diminishing its obstructive power.

Gouley[1] adopted Mercier's procedure through a perineal incision. The instrument resembles a lithotrite, and consists of a male and female blade, one sliding in the other. It is made to cut or punch out segments of the overgrowth. In this way extensive portions may be removed.

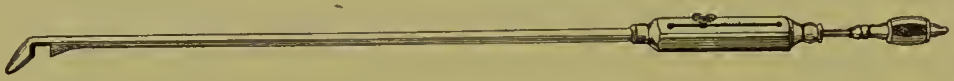

FIG. 89.—Gouley's prostatome.

Norton[2] has devised an instrument closely resembling Gouley's, which is used in the same manner.

It is evident that these procedures would be suitable only for cases of involvement of the middle lobe or of a bar at the neck of the bladder. They would not be suitable for hypertrophy of the lateral bodies.

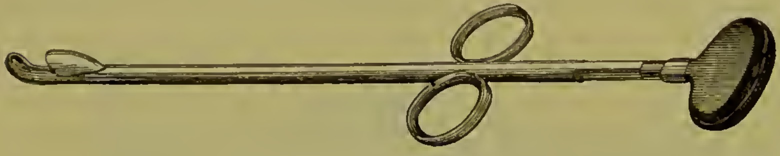

FIG. 90.—Norton's prostatome.

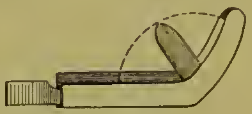

FIG. 91.—Maisonneuve's sécateur.

Prostatectomy.—Extirpation of a portion or all of a prostate the seat of hypertrophy would naturally seem to be a rational means of securing relief from the obstruction to the discharge of the urine.

In operating for the removal of portions of the enlarged prostate the gland may be approached through a perineal incision, or through the bladder after performing the usual suprapubic cystotomy, or, as has been recommended by Belfield and others, by a combination of these two. Opinions are divided regarding the relative value of these procedures. Woolsey[3] has

[1] *Amer. Surg. Ass'n*, 1885.

[2] *Med. Press and Circ.*, Jan., 1892.

[3] *Journ. of Cut. and Gen.-urin. Dis.*, July, 1895.

recently made an exhaustive study of the choice of operation in these cases. The difference in the views of the various writers on this subject is due to the particular conception of the underlying conditions upon which depends the urinary obstruction in enlargement of the prostate. McGill, for example, whose efforts succeeded in placing prominently before the profession the suprapubic operation, believed (1) that prostatic enlargements which give rise to urinary symptoms are intravesical and not rectal, and (2) that retention is caused by a valve-like action of the intravesical prostate, the urethral orifice being closed more or less completely by the contraction of the bladder on its contents.[1] It is clear that if these propositions were true of every case, the suprapubic route should always be selected. Watson[2] found among 30 specimens 28 in which the principal hindrance was an outgrowth at the vesical outlet, and in 10 cases this was the sole source of obstruction.

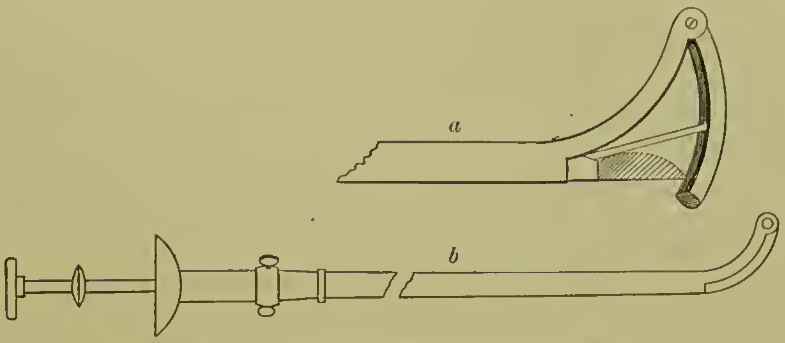

FIG. 92.—Civiale's kiotome: *a*, open; *b*, closed.

On the other hand, von Dittel claims that hypertrophy of the middle lobe is usually accompanied by a more or less considerable enlargement of the lateral masses.[3] Many others hold the same views. Eigenbrodt states that the median portion only is prominently enlarged in but 19 per cent. of the cases.[4] Desnos[5] found the median portion enlarged 12 times in 47 cases. Vignard[6] found manifest hypertrophy at the level of the neck of the bladder in 12 cases among 28 specimens in the Musée Civiale. Fenwick[7] makes the statement that 90 per cent. of the prostatic obstructions are due to enlargement of the middle lobe. Browne claims that the intravesical form of growth is the chief source of difficulty in micturition.[8] This view is endorsed by Hutchison, who believes that it is the projecting and valve-like vesical lobe which alone constitutes the impediment.[9] This opinion is also shared by Kümmel,[10] who thinks this tumor-like middle lobe is more common than is

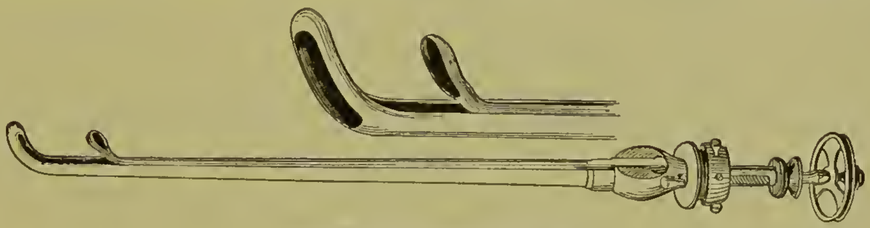

FIG. 93.—Mercier's exciseur.

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[1] *Brit. Med. Journ.*, Oct. 19, 1889.

[2] *Annals of Surgery*, 1889.

[3] *Wiener klin. Woch.*, 1890, No. 18.

[4] *Beitr. z. klin. Chir.*, 91–92, viii.

[5] *Traité elém. de Mal. des Voies urin.*, Paris, 1890.

[6] *Ann. de Mal. des Org. Génito-urin.*, Paris, 1890, viii.

[7] *Lancet*, Lond., Jan. 16, 1892.

[8] *Ibid.*, 1893, vol. i.

[9] *Archiv. Surg.*, London, 1892–93.

[10] *Festschr. zum 70te Feiertag Fr. v. Esmarch*, 1893.

usually supposed. Tobin[1] states that a study of specimens of enlarged prostate shows that it is in the cases in which the median lobe is movable, and therefore removable, that retention is most complete.

Belfield has collected 63 cases of prostatic obstruction operated upon, of which tumors involving the middle lobe occurred 37 times, lateral tumors 9 times, median and lateral tumors 5 times, collar-like enlargements 7 times, horseshoe enlargements 3 times, and diffuse enlargement in 2 cases.[2]

As showing the importance of the lateral bodies in causing obstruction a case of M. Schmidt's[3] is of interest. After removing the enlarged middle lobe through a suprapubic incision, he was obliged subsequently to make a median perineal section, to remove the urethral obstruction piecemeal, dilate the urethra, and use a *sonde à demeure*[4] on account of the failure of the first operation. Spontaneous urination was secured only after further dilatation of the prostatic urethra.

Von Dittel's experiments are very instructive in this connection. He found that a wax bougie left for twenty-four hours in the prostatic urethra in cases of hypertrophy was compressed laterally. He also studied, post-mortem, the outflow of water introduced into the bladder with the organs in position and after their removal from the body. He found—(1) with the normal prostate the water flowed away completely in a short time. (2) When bilateral hypertrophy existed the water flowed away only partly when the bladder was filled under strong hydrostatic pressure, about 30 per cent. of residual water remaining. Residual water remained after a vertical median prostatotomy was done, but all the fluid flowed away promptly when the lateral lobes were resected from the exterior. (3) In a case of general hypertrophy of the prostate the median portion was cut out as a wedge-shaped piece, but a slow and incomplete emptying of the bladder resulted until a wedge-shaped portion was removed from both lateral lobes. The bladder then promptly emptied itself.[5]

There is no doubt that a more important rôle is played by the lateral lobes than has heretofore been accorded them. McGill has felt it necessary to remove a considerable amount of the extravesical portion. Keyes[6] reports having removed the lateral lobes as far as one-half of the length of the gland downward and forward. Further, Küster has performed lateral prostatectomy in 3 cases with results so successful that we are compelled to admit the influence of the extravesical portion of the lateral lobes as a factor in prostatic obstruction.

As a result of his studies, Woolsey considers the following conclusions justifiable: (1) that intravesical prostatic growth is not always, though perhaps most often, the cause of obstruction requiring operative relief; (2) that in such cases the median portion plays a most important part by forming a valve in the majority of cases; (3) that the lateral lobes are often important factors both intra- and extravesically, but especially in the latter manner.

The specimens reproduced on pages 273–277, all of which have been obtained during the preparation of this paper, add conclusive evidence to this subject. Fig. 76 illustrates a specimen in which the middle lobe was enormously hypertrophied without any enlargement of the lateral lobes. Fig. 75 shows a case in which the lateral lobes are very greatly increased in size (the left much more than the right), while the middle portion is barely perceptible. In the fresh condition the vesical neck was funnel-shaped, the apex of the funnel being almost at the apex of the prostate, and the prostatic urethra did not appear encroached upon at any point, and yet the retention was just as absolute in the latter as in the former. In the case illustrated by Fig. 76 there was but little residual urine. It is clear, therefore, that we are not yet in a position to dogmatize in this matter. Each case will require careful study, and the treatment determined upon accordingly.

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[1] *Dub. Journ. Med. Sci.*, 1891, xcii.

[2] *Am. Journ. Med. Sci.*, Nov., 1890.

[3] Quoted by v. Dittel: *Wiener klin. Woch.*, 1890, No. 18.

[4] The name given by the French to a catheter introduced into the bladder and retained for continuous drainage.

[5] *Wiener klin. Woch.*, 1890, No. 18.

[6] *Journ. Cutan. and Gen.-urin. Dis.*, 1892.

In choosing one or other form of operation the following considerations will aid in reaching a decision: Obstruction due to intravesical growths could be most satisfactorily, and in some cases only, reached through the suprapubic incision, while those depending on enlargement of the lateral lobes could best be dealt with from the perineum. It will often be difficult, however, to come to a conclusion in these cases, because, as has been shown, the obstruction seems to depend on something more than the mere extent of the enlargement, inasmuch as in some cases with a great degree of overgrowth there is but slight obstruction present, while, on the other hand, in some cases of apparently quite moderate hypertrophy the urinary symptoms are pronounced.

Suprapubic Prostatectomy.—McGill, who has been a strong advocate of this operation, claims for it (1) perfect drainage of the bladder, and (2) the opportunity permanently to remove the cause of the obstruction. He also claims that it is more generally applicable, that it can be performed with greater precision and completed with greater certainty, and that it is as safe as the perineal operation.[1]

These claims are, however, not universally conceded. Woolsey does not accept the statement that the suprapubic incision provides efficient drainage. He claims that the pocket left as the result of the prostatectomy will not be well drained in this way, but that perineal drainage is much more efficient. In this view he is in accord with Chance,[2] May,[3] and others.

The forms of intravesical outgrowths described by McGill are—(1) projecting middle lobe (pedunculated or sessile); (2) median and lateral lobes, forming three distinct projections; (3) lateral lobes; (4) pedunculated growths from the lateral lobe; and (5) uniform circular or collar-like projections surrounding the internal urethral orifice.

Operation.—The field of operation should be shaved and cleansed in the manner habitually employed in advance of operations at the present time, and the patient should have received the usual preparatory treatment.

The following instruments will be required: scalpel, blunt-pointed bistoury, scissors (straight and curved), sharp hook, blunt hooks, dissecting, artery, and hemostatic forceps, broad rectangular retractors, rectal bag, syringe, large drainage-tube, needles, sutures, ligatures. The retractor devised by Watson may be employed with advantage.

For operation the patient is placed upon the back; the shoulders may be raised upon a pillow. Occasionally, it may be desirable to operate in the Trendelenburg position; some operators habitually employ this posture. The surgeon stands on the patient's right side. The empty rectal bag is oiled with vaseline and introduced into the rectum well above the internal sphincter. The filling of the bag may properly be delayed until a later period. A soft-rubber catheter is then introduced into the urethra, or, if this will not pass, any other form that will enter the bladder is employed to draw off the urine, after which the bladder is irrigated with warm boric-acid solution until the fluid returns clear. The bladder is then moderately distended with the solution, which is allowed to remain, the catheter being withdrawn. The quantity that can be used will vary greatly with different cases. It is not always possible to employ a given amount, as can be done in performing cystotomy upon the healthy bladder, the walls of which have not been altered by disease. It is desirable, when possible, to distend the bladder until it can be detected above the pubes. The rectal bag is next filled with warm water, six to ten ounces being employed. Some operators prefer not to distend the rectal bag until the bladder has been reached; others prefer to distend the rectal bag before injecting the bladder, as by this order of procedure the projection forward of the bladder is rather more pronounced.

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[1] *Brit. Med. Journ.*, Oct. 19, 1889.

[2] *Med. Press and Circ.*, Lond., 1894, N. S. lviii. 3.

[3] *Brit. Med. Journ.*, Oct. 19, 1889.

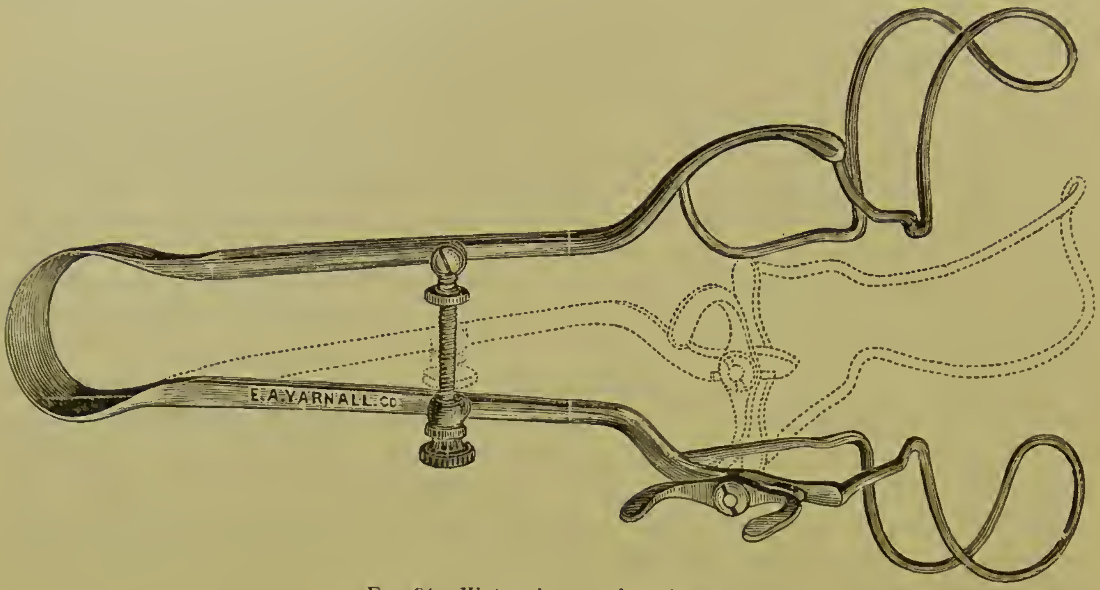

FIG. 94.—Watson's speculum (open).

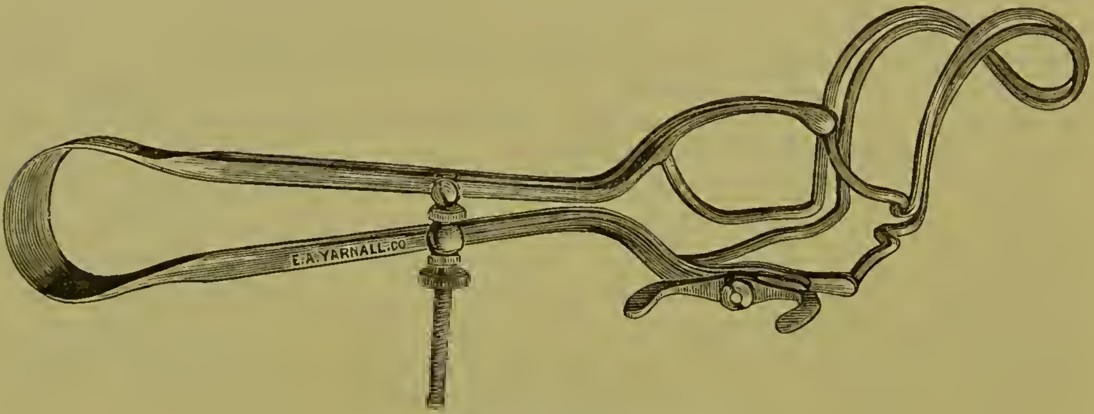

FIG. 95.—Watson's speculum (shut).

McGill of Leeds, after whom this operation is sometimes called, emphasizes the following points in the technique of the operation:

(1) The quantity of water injected into the rectal bag, especially in cases where the prostate is abnormally hard, should be smaller than the quantity usually recommended. Each case must be decided upon its merits, but six to ten ounces are usually sufficient.

(2) The bladder should be irrigated till the antiseptic solution used is perfectly clear. The quantity left in the bladder varies from ten to twenty ounces or more. [In our opinion it will rarely be proper to exceed ten fluidounces, and frequently it is not safe to introduce more than six or eight.] The hand placed on the hypogastrium during the filling of the bladder will show when the distention is sufficient.

(3) In cases where the bladder is contracted with thick, non-distensible walls it will usually be inadvisable to perform this operation.

(4) It is better to leave a catheter in the bladder till its cavity is opened, as it is a guide that expedites the operation. Care must be taken not to hook the peritoneal fold (superior false ligament) into the wound with the point of the instrument.

(5) The linea alba is best divided by incising it immediately above the symphysis, and then dividing upward on a director.

(6) Care must be taken to secure the bladder before proceeding to remove the prostate. This is best done by inserting two sutures through each lip of the wound, and fastening it securely to the deeper part of the abdominal wall. When the operation is completed a third suture passed through the lower angle of the wound is an additional security against urinary extravasation into the retropubic space.

(7) A pedunculated middle lobe can be removed with ease, its pedicle being divided with curved scissors. A sessile middle lobe can be removed in the same way, helping the scissors by tearing with forceps. The collar enlargement is removed with greater difficulty. It is advisable to divide it longitudinally by inserting one blade of the scissors into the urethral opening and dividing the portion above, and then passing the other blade into the same opening and dividing the portion below. That part of the gland which projects into the bladder is now divided into two lateral halves; these can be removed separately by scissors curved on the flat or enucleated with the tip of the fore finger. Care must be taken not to leave any portion of the projecting valve untouched.

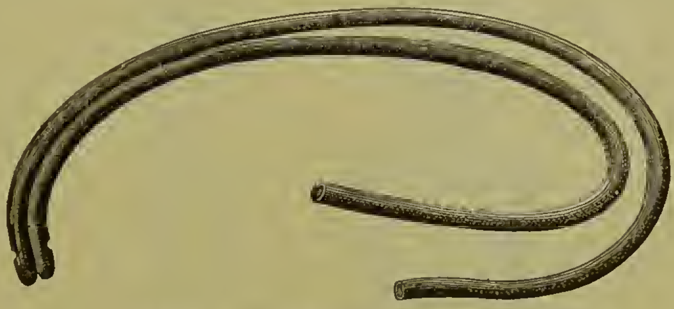

FIG. 96.—Guyon's double drainage-tube.

The prostate should be removed as far as possible by enucleation with the finger, and not by cutting. The mucous membrane over the projecting portion having been snipped through, the rest of the operation is completed with finger and forceps. In this way excessive hemorrhage is prevented. Hemorrhage is best arrested by irrigation with water so hot as to be unpleasant to the hand.

When the operation is complete, whichever form of growth has been removed, it is advisable to see that the urethra is patent, and to pass the fore finger as far as the first joint into its canal.

(8) A large tube should be inserted into the bladder, and the wound

united above the tube by a deep and superficial row of sutures. The tube is to be removed in forty-eight hours.

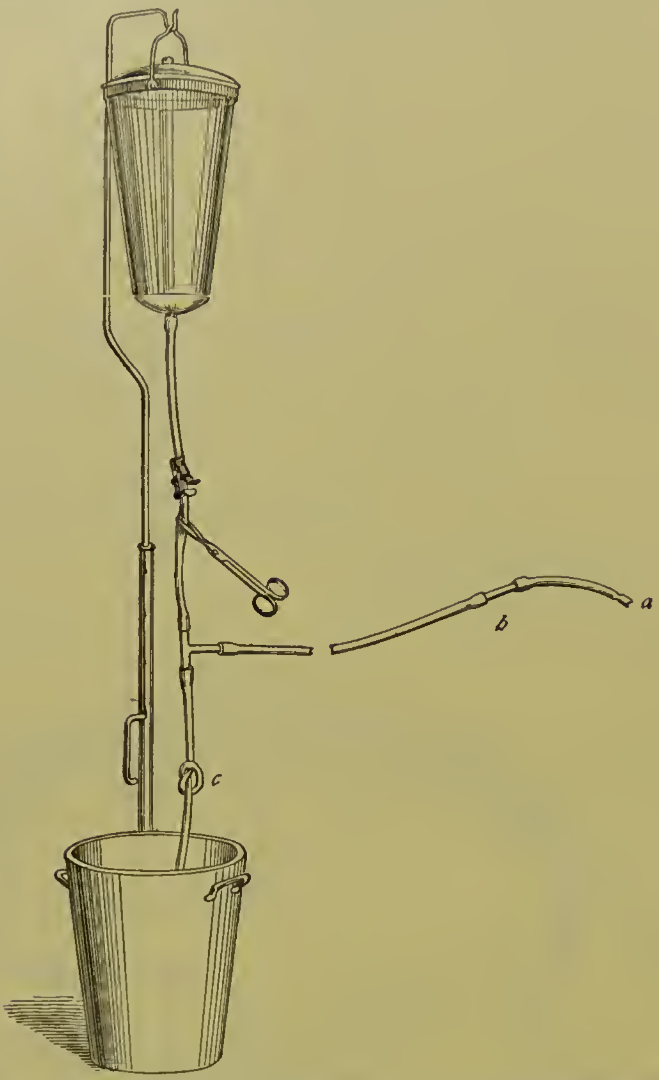

FIG. 97.—Apparatus for draining bladder after suprapubic cystotomy: *a*, end of rubber tube to be placed in *bas fond* of bladder; *b*, glass tube; *c*, trap (Dawbarn).

(9) The after-treatment consists in keeping the parts clean and washing the bladder and the wound with boric-acid solution.[1]

Browne[2] advises that the bladder be opened on a staff: since the body of the prostate is in some instances very large, it is apt to be incised instead of the bladder when the surgeon thinks he is puncturing the latter organ

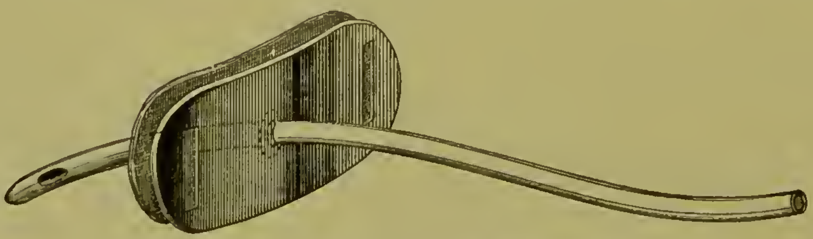

FIG. 98.—Plate to secure catheter in suprapubic drainage.

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[1] *Lancet*, Lond., Feb. 4, 1888.

[2] *Brit. Med. Journ.*, March 11, 1893.

with the knife. He recommends also that the projecting portion of the prostate be removed with forceps, twisting it off in one piece if small, and piecemeal if large. The torsion greatly diminishes the amount of hemorrhage.

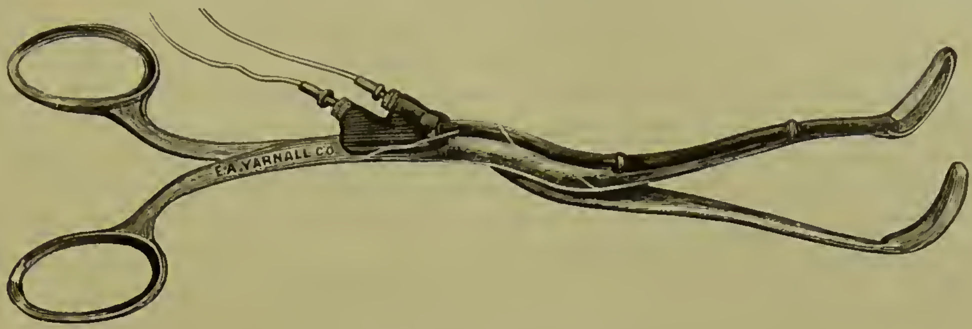

Fig. 99.—Watson's scissors-cautery.

Some authors prefer the transverse incision above the pubes, dividing the recti muscles, as advised by Trendelenburg.[1] Kümmel[2] sutured the bladder and drained through the perineum with a Nélaton catheter. For the cases in which the obstruction at the neck of the bladder is dense, Keyes[3] accomplishes its thorough removal by means of the rongeur, thus solving this hitherto unsettled question. For those in which the enlargement of the middle lobe takes the form of a distinct projection Weir[4] recommends

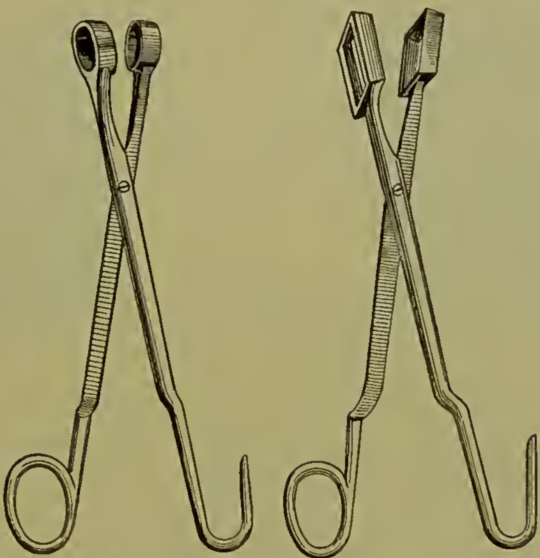

Fig. 100.—Prostate-scissors (Jessop).

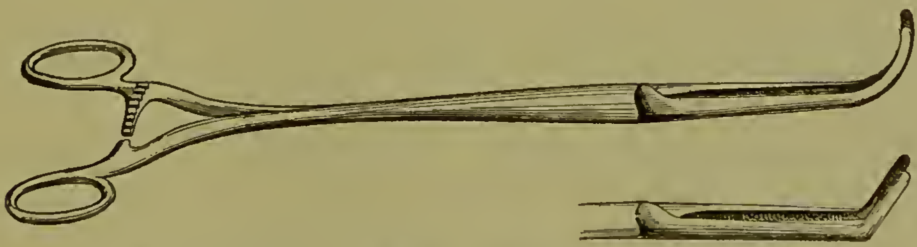

Fig. 101.—Forceps for twisting away bladder-growths, etc. (R. Harrison).

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[1] *Brit. Med. Journ.*, Oct. 19, 1889.

[2] *Deut. med. Woch.*, April 8, 1889.

[3] *Med. Rec.*, New York, Oct. 31, 1891.

[4] *N. Y. Med. Journ.*, May 30, 1891.

the use of the amygdalotome in effecting its removal. One may also employ Watson's scissors-cautery (Fig. 99), Jessop's scissors (Fig. 100), or Harrison's forceps (Fig. 101), the choice of the particular instrument being determined by the form of the median enlargement.

For the control of the excessive hemorrhage that sometimes occurs in removing sessile growths Keyes[1] adopted the use of a tampon composed of bichloride gauze made as follows: A square of four thicknesses of gauze is cut, the length of each side being about 6 inches. Upon this are placed eight thicknesses of gauze cut square, each side measuring 4 inches, and upon this eight other thicknesses, also square, the sides measuring 3 inches. Centrally, upon the 3-inch pad a small white shirt-button is tied by stout silk ligatures transfixing the pad and tied upon the 6-inch square surface. This central button also has a piece of silk attached to it running out freely in the direction away from the 3-inch surface. This is to facilitate extraction. Each of the corners of the 6-inch pad is stoutly tied with a piece of silk, and the silk from each of these four corners is knotted at its end into a double knot, while the silk running out backward from the button is tied with a single knot for the purpose of distinguishing which is which when making the extraction, although, practically, it will be found that they must all be made taut and pulled upon all together in order to effect removal with the greatest care and facility.

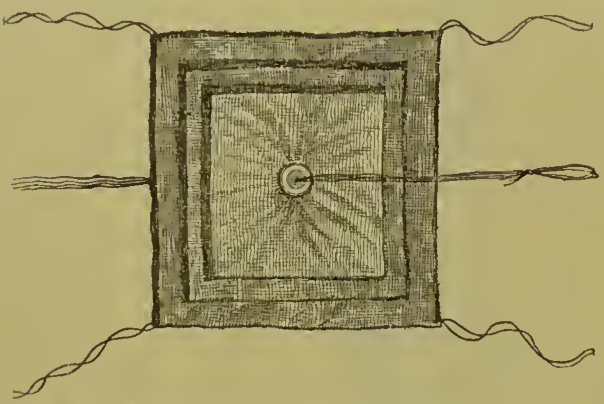

FIG. 102.—Keyes's pad for controlling hemorrhage after prostatectomy.

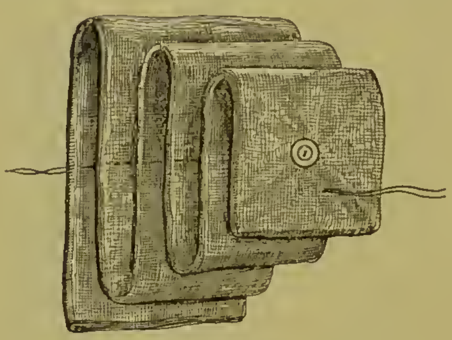

FIG. 103.—Cabot's pad for controlling hemorrhage after prostatectomy.

The pad is applied by introducing a catheter through the urethra into the bladder, attaching the silk threads from the center of the 6-inch surface, and withdrawing the catheter. The threads are then tied over a roll of gauze at the meatus in order to keep the pad firmly in place. If a perineal opening has been made, the threads are brought out of this incision and similarly tied over a piece of gauze. On account of the difficulty experienced in removing this tampon Cabot[2] suggested the following modification: A long strip of gauze, of appropriate width, the edges of which should be rolled in and stitched so that there should be no loose, frayed edges, should be folded back and forth upon itself to form a pad of the proper size. The folds are made shorter each time, so as to produce a pad somewhat cone-shaped. For the same reason the strips of gauze should be broader at one end than at the other by 2 inches. A silk thread, attached to a button, is passed through the center of all the layers of the pad from the surface having the smaller to that having the larger diameter, so that the button is at the extremity of the gauze strip representing the last fold. The thread is to be carried through the perineal opening or through the urethra and secured, in order to make the necessary traction as described in connection with Keyes's pad. The pad should have another thread attached to the upper extremity of the strip to remove it by. This pad could be drawn into the neck of the bladder as firmly, Cabot thinks, as any compress ; but on loosening the thread which passes through the perineum or urethra, and then drawing on the upper thread, the gauze would unfold and come out in a long strip, much as the packing which one applies to a bleeding uterus does.

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[1] *Med. Rec.*, New York, Sept. 17, 1892.

[2] *Ibid.*

The following procedure has been recommended by Tobin :[1] A small suprapubic cystotomy is performed, and the condition of the enlarged prostate estimated by means of the finger introduced through the wound. A wire of sufficient length is then doubled, and the loop passed through the urethra into the bladder. By means of two fingers in the suprapubic opening the loop of wire is made to encircle the prostatic outgrowth. A special metal catheter with the vesical end open is then passed over the wire until the point comes in contact with the obstruction. The wires are then drawn upon, and, being contained within the catheter, act as an écraseur, the two fingers in the bladder guiding the wire loop in the proper direction as it makes its way through the prostatic growth. Tobin claims the following advantages for his method : (1) As much of the gland as interferes with the escape of the urine is removed and no more ; (2) such portion is removed in a satisfactory manner, for the wire cuts up to the portion where the instrument has been stopped by the obstruction ; (3) a smooth surface sloping into the urethra is left, instead of the more or less rough one that must result from taking away the gland piecemeal by means of forceps ; (4) there is very little hemorrhage. It is obvious, however, that this method would be applicable only to the cases in which there was a distinctly localized growth of the median portion.

Perineal Prostatectomy.—The patient, having had the necessary preliminary preparation, should be placed in the lithotomy position, and a staff introduced as in the operation of median perineal cystotomy. The surgeon inserts the left index finger into the rectum and steadies the staff with the point of the finger, which is pressed against it at the apex of the prostate. A narrow, double-edged bistoury is then thrust into the median raphé of the perineum half an inch in front of the anus. It is introduced horizontally, with the longer cutting edge directed upward. The groove in the staff is "hit" at the point where it is steadied by the finger in the rectum, and by continuing to thrust the knife deeper the apex of the prostate is incised and the prostatic urethra is opened, the superficial wound being enlarged upward as the knife is withdrawn. By this method small median tumors may often be caught by forceps and removed. Portions of the lateral lobes have also been removed by scissors or forceps or by being torn away with the finger or sharp spoon. Watson[2] states that in two-thirds of the cases of enlarged prostate needing treatment the intravesical growth could be successfully reached and partially or wholly removed through a perineal incision.

Wishard[3] favors this operation in cases in which the deep urethra is not so much lengthened by the prostatic hypertrophy as to prevent the finger introduced through the perineal wound from reaching beyond the growth. He states that catheter measurements of the prostatic urethra, together with the rectal examination, are usually sufficient to determine the operator in making the choice as to the method of operation.

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[1] *Med. Press and Circ.*, Lond., 1892, N. S., vol. ii.

[2] *Operative Treatment of the Hypertrophied Prostate*, 1888.

[3] *Indiana Med. Journ.*, Oct., 1892.

Several other methods of approaching the prostate from the perineum have been recommended. Von Dittel[1] recommends cuneiform resection of each lateral lobe of the enlarged prostate, to which operation he applies the term "lateral prostatectomy." The steps of the operation are as follows: (1) Introduce a catheter [or sound] into the bladder through the urethra, and tie so that the urethra may be easily appreciated during the operation, and thus avoided; (2) pack the rectum with gauze, that it also may be recognized and avoided; (3) the patient is placed prone on a table with the legs hanging down over the end: the incision begins at the tip of the coccyx, and is continued down the middle line to about the middle of the sphincter ani, and thence around the anus nearly to the raphé; (4) dissect away the rectum and expose the prostate; (5) arrest hemorrhage and render the wound aseptic; (6) cut away as much as possible of each lateral enlargement, leaving only a small amount of substance to protect the urethra; (7) arrest hemorrhage, pack lightly, and drain.

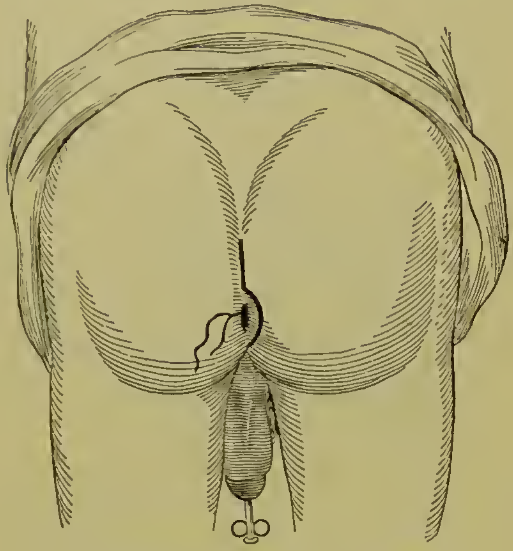

FIG. 104.—Dittel's operation for prostatectomy.

Warholm[2] has modified von Dittel's method by making the incision from one ischial tuberosity to the other. A sound is passed into the urethra and the rectum tamponed with iodoform gauze. On dividing the venous plexus on the posterior surface of the prostate considerable hemorrhage may be encountered, and is to be arrested by tampons or ligatures. When hemostasis is obtained cuneiform resection of both lateral lobes is performed. The wound is drained and closed.

Von Dittel's operation has been carried out by Küster[3] in 3 cases, a portion of the gland only being removed in each. Von Dittel reports a successful case in which he removed the whole gland by his external method,[4] and Pyle[5] reports a successful case operated upon by a similar method.

L. Bolton Bangs[6] relates a very interesting case in which overstretching of the prostatic urethra incident to a perineal lithotrity proved to be of distinct benefit in relieving prostatic symptoms which had existed previous to the stone-formation. Woolsey[7] records that in a personal communication Dr. Bangs had stated that the effect in this case was only temporary, indicating that the lateral hypertrophy requires a more active treatment than simple stretching.

Woolsey[8] gives the details of a case upon which he performed von Dittel's operation of lateral prostatectomy. The man was sixty-two years of age. He came to the hospital on account of retention of urine. He had had two suprapubic operations performed by other surgeons. The suprapubic opening was enlarged, and drainage thus obtained; a catheter was introduced into the urethra and retained. The suprapubic fistula remained; there was no diminution in the size of the prostate, and spontaneous urination did not take place.

[1] *Wiener klin. Woch.*, 1890, No. 18.

[2] *Gaz. heb. de Méd. et de Chir.*, Jan. 2, 1896.

[3] *Münch. med. Woch.*, April 14, 1891.

[4] *Intern. klin. Rundschau*, Vienna, June 18, 1893.

[5] *Med. Rec.*, New York, Aug. 6, 1892.

[6] *Annals of Surgery*, April, 1893.

[7] *Journ. Cutan. and Gen.-urin. Dis.*, Aug., 1895, p. 314.

[8] *Op. cit.*, August, 1895.

The operation was performed, as described by von Dittel, by making a median incision from the coccyx to and around the left margin of the anus and extended one inch anteriorly. After division of the skin and fascia the upper part of the ischio-rectal fossa was reached by blunt dissection without hemorrhage, after ligation of only one or two vessels. The levator ani muscle was divided antero-posteriorly on the left side of the prostate, exposing the latter, which was freed by the finger on all sides. Although the prostatic plexus looked large, but little bleeding occurred on removing a large boat-shaped piece from either side. But little was left of the prostate and the urethra was not injured. The catheter was tied in the urethra and the wound packed; recovery was uneventful. He was able to pass urine much more freely than before, though the suprapubic fistula remained. The patient died, however, three or four months later, it is supposed from a cancer.

Woolsey states that, so far as it is justifiable to reach any conclusion from so limited an experience, he should say that the operation is feasible, easy, and safe.

Pyle[1] advocates the following method of removing the prostate: A semicircular incision is made around the anus anteriorly, midway between the tuber ischii, entering between the bulb of the urethra and the rectum. There is no hemorrhage to speak of, and the access to the gland is easily accomplished. After dividing the integument and tough fascia the loose tissue is to be separated with the handle of the scalpel, working between the rectum and urethra until the fascia covering the levator ani is reached, the division of which exposes the prostate. The gland may be grasped with a volsellum forceps and enucleated with the finger. It will usually be desirable to insert a bougie into the urethra to act as a guide and to prevent injuring this structure.

Combined Suprapubic and Perineal Prostatectomy.—On account of the fact that neither the suprapubic nor the perineal operation permits of dealing radically with the prostate in every case, a number of surgeons have advised the combination of the two. Belfield[2] states that the addition of the boutonnière increases but slightly the injury to tissue and the time of anesthesia, while it affords an access to the entire prostate which may convert an utter failure into a complete success. He believes the combined operation should be the rule rather than the exception.

Nicoll,[3] in order to obviate lacerations and tears of the mucous membrane of the vesical neck and deep urethra, recommends the following procedure in removal of the prostate: A suprapubic cut is made, the bladder opened, and the sides of the vesical incision sutured to the corresponding margin of the abdominal wound. A median perineal incision is next performed, and the capsule of the prostate opened without incising the urethra. With one hand in the suprapubic wound he presses down the prostatic growth, so that it is steadied and brought into reach of the fore finger of the other hand introduced through the median cut. By this means the perineal finger gradually shells out the growth. If the growth is too fine and fibrous to be removed by the finger, then an instrument much like a periosteum-scraper does the work. In case the median incision does not give room enough in the region of the prostate, lateral incisions can be made much as in von Dittel's procedure. The hand in the bladder can detect when all the obstruction has been removed.

Desnos,[4] who has performed 22 resections of the prostate for hypertrophy during the past seven years, summarizes his results as follows: 2 deaths, 1 aggravation of urinary symptoms, 4 not improved, and 15 improved or cured. One death, which occurred on the fifth day, was from previous infection, which the cystotomy did not relieve; the other, on the eighth day, suddenly followed an effort of the patient to raise himself up in bed. In the case in which aggravation of the symptoms was noted there was a certain degree of incontinence which did not exist before.

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[1] *Med. Rec.*, New York, 1892, vol. xlii.

[2] *Sys. Genito-urin. Dis., Syphilology, and Dermatology*, vol. i.

[3] *Lancet*, Lond., April 14, 1894.

[4] *Annales des Mal. des Org. Gen.-urin.*, Dec., 1895.

The "improvement" consisted in a diminution of the amount of urine retained (in 6 of the cases retention completely disappeared); urination had become less frequent and but slightly painful. In cases in which infection of the bladder had occurred the urine had become almost, if not quite, clear. Four of the patients, whose general health had been seriously disturbed, rapidly recovered, the appetite and strength returning in a few weeks.

As to recurrence, the first two patients operated on, now sixty-six and seventy-one respectively, have rather frequent micturition, but there is no retention, and they have not had to recur to the catheter. The others are still occasionally subject to cystic infection when antiseptic irrigations are required; the inflammation yields to this treatment. In one case, after a period of amelioration, the pains returned so severely that a cystotomy was necessary. Some of the others have had a slight increase of residual urine after a temporary improvement due to the operation.

As to age, only in the relatively young is the operation a success. Over sixty-five years of age only once was relief given. In the others retention was not lessened and the bladder rapidly lost its contractility.

Castration.—In the autumn of 1892 one of the writers was asked to prepare a paper on "The Present Position of the Surgery of the Hypertrophied Prostate." In thinking over the subject, the apparent analogy between prostatic growths and uterine fibro-myomata seemed to him to demand investigation, and it was determined, if possible, to ascertain whether castration would have the same effect upon the hypertrophied prostate that oöphorectomy does upon similar growths in the uterus. Experiments were at once instituted upon a a large number of dogs, which showed that castration invariably caused a rapid and pronounced diminution in the size of the normal gland. Microscopic sections showed that the decrease in size was a true atrophy. Upon the result of these experiments "castration" was suggested for hypertrophy of the prostate.[1]

Since this time the operation has been performed a great number of times in all parts of the civilized world, with better average results than have been obtained by any other form of treatment hitherto employed. Castration may be said to have passed the experimental stage, and to have established for itself a place among legitimate operative procedures.

The following reports illustrate the results of castration in properly selected cases:

Case 1.—The first patient subjected to castration for hypertrophy of the prostate in this country was operated upon by Dr. Francis L. Haynes of Los Angeles, Cal., Dec. 12, 1893. Dr. Haynes was led to carry out this procedure by the experimental evidence placed before the profession in the paper before alluded to.[2] The patient was an old man with chronic cystitis, frequent urination—passing water from four to eight times during the night; the residual urine measured half a pint. He had not urinated with ease for two years. The prostate was moderately hypertrophied. The catheter had to be used from one to three times daily. The operation was followed by relief of the urinary symptoms, shrinkage of the prostate, and disappearance of the cystitis. At the end of three months the patient considered himself entirely cured. He urinated with ease, there was no cystitis; he used the catheter once in four days to estimate the amount of residual urine, which was about three drams. A letter from Dr. Haynes, dated Aug. 5, 1895 (one year and eight months after the operation), states that the patient remains perfectly well. He rises once at night, passes water about five times during the day, and is able to retain his urine for nine hours at a time. The urine is normal; the prostate has nearly disappeared. His mind is in excellent condition and his general health perfect.

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[1] Paper read before the American Surgical Association, June, 1893: *Annals of Surgery*, August, 1893.

[2] White: *Ibid.*

CASE 2.—The following case, which Dr. White saw with Dr. F. Fremont Smith of St. Augustine, Florida, during the Christmas holidays of 1893, was a most remarkable one:[1] "On October 25, 1893, a patient was admitted to St. Alicia Hospital, St. Augustine, who had suffered for a year with mild symptoms of prostatic hypertrophy. During the month previous to his admission increasing symptoms of obstruction had set in. During the seven and a half weeks after admission he suffered with irregular fever; urination was painful and frequent, especially at night, and the urine was loaded with the products of decomposition and pus. Attacks of retention were frequent, and the smallest amount of residual urine was six ounces.

"From Oct. 25th to January 17th the usual and approved internal treatment and bladder-douches were carefully carried out by Drs. Fremont Smith, Alexander, and Anderson. During this period the patient steadily declined. The depression of repeated acute inflammatory attacks, each recurrence accompanied by excess of pus and septic fever, the harassing constancy of the desire to urinate, and the necessary loss of appetite and sleep, with the other effects of the local disease, reduced his weight during these seven and a half weeks from 165 to 135 pounds. His weakness was alarming; all unfavorable symptoms were increasing."

The patient's condition now appeared most hopeless. It really seemed that from the amount of cystitis and septic intoxication he could not survive more than a few days. Any form of prostatectomy was evidently out of the question. He seemed too ill even for formal cystotomy. It did not seem reasonable to hope that castration would be of any avail at such a late period in the disease, but it was advised under the circumstances, inasmuch as it could be done with less ether and hemorrhage, and consequently with less shock, than any of the other operations usually recommended.

The operation was performed on January 17, 1894. "During the week following the patient was catheterized twice daily. At the end of that period he attempted and successfully voided his urine, and the catheter was used twice a week, alone for the purpose of determining the quantity of residual urine. No local treatment was employed subsequent to the operation. March 1st, six weeks after operation, the patient was discharged. His general conditions were changed, in that he had subsequent to castration no fever from any source, his appetite returned, his weight increased from 135 to 163 pounds, his mental state, previously weak and melancholic, made decided improvement. His local conditions were changed, in that, instead of retention or residual urine of not less than six ounces, he had no retention, attack, or return of acute cystitis, and the residual quantity steadily diminished and during the final week varied between three drams and one and one-half drams. The nocturnal desire to urinate was reduced from twelve and fifteen to four and six times. The urine now presented a sediment only on standing for hours, which contained under the microscope a moderate number of pus-cells."

A recent letter states that the patient has no difficulty whatever in voiding his urine, and no pain at all from that source.

CASE 3.—As another example, one may be mentioned from the practice of Dr. White: A man aged seventy-nine years had had symptoms of obstruction to urination for eight years. He had marked cystitis and six ounces of residual urine. He was obliged to use the catheter four to six times daily. The prostate was about the size of a small orange. On January 26, 1895, castration was performed. Three days later the retention was replaced by incontinence. The latter had disappeared by the 1st of April, at which time the patient voided urine about five times daily; the prostate was greatly reduced in size. The patient was seen on the 2d of May. He had remained entirely well. The urine was perfectly clear, his cystitis having disappeared.

CASE 4.—The following additional case may be quoted:[2] A shoemaker, sixty-eight years of age, had first noted undue frequency of urination fifteen years before coming under observation. The frequent micturition gradually became painful; at times the suffering was intense. Finally, he noticed incontinence and loss in the force of the stream. He was obliged to rise as many as twenty times during the night. Later, he had complete retention; catheterization became very difficult and caused a great deal of pain. The patient failed in strength and became delirious; the urine, which had been ammoniacal and offensive for years, became more foul; the quantity was markedly diminished, and all of the symptoms suggested a rapidly fatal termination. The temperature was 101; pulse 110 and weak. November 9, 1894, both testicles were removed. The condition of the patient at once began to improve; he gradually came out of his uremic state; spontaneous urination gradually returned; he was able to do away with the catheter; the pain disappeared, and also the frequent desire to urinate. The cystitis was entirely relieved, and the condition of the urine normal. There was no residual urine. The prostate diminished from the half-orange-like projection to a flattened, scarcely perceptible mass. March 10, 1895, sixteen months after the operation, the patient was shown before the Surgical Section of the College of Physicians of Philadelphia. He had been, in the interim, entirely free from urinary troubles, and stated that he urinated as freely as when a boy. He was obliged to rise but once or twice during the night, and passed urine which was normal and free from pus six times during the day.

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[1] *Annals of Surgery*, July, 1894.

[2] *University Medical Magazine*, May, 1896.

It is understood, of course, that every case subjected to this operation has not been as successful as those quoted, and death has followed the operation in some instances. The object has been, however, to demonstrate the possibilities of castration in a large proportion of cases of enlargement of the prostate, and to use the facts thus brought out in discussing certain problems in connection with this subject.

The Status of the Operation.—In the first tabulation of the results of castration for prostatic hypertrophy,[1] it was shown that in approximately 87.2 per cent. of the cases there was a rapid atrophy of the prostate, that a long-standing cystitis disappeared or was much improved in 52 per cent., that vesical contractility returned in 66 per cent., that there was amelioration of the most troublesome symptoms in 83 per cent., and a return of local conditions not very far removed from normal in 46.4 per cent. Strikingly similar are the observations of P. Bruns,[2] who has analyzed 148 cases. Among 93 of these cases, in which accurate notes were made, the prostate decreased in size 77 times (83 per cent.). Cabot[3] has collected 99 cases not included in Dr. White's table. His analysis of these shows: "failures, 9.8 per cent.; moderate improvement, 6.6 per cent.; substantial or very great improvement, 83.6 per cent." Bruns[4] states that microscopic examination of the prostates of two patients who died subsequent to castration showed that the decrease in size was due to a true atrophy (first of the glandular elements and then of the stroma). This is in accord with the observations of Griffiths[5] and of White.[6] Cabot[7] reports examining microscopic sections of the prostate of a man who died seven days after castration. He failed to find any difference from the hypertrophied prostate of a non-castrated patient. In a second case, examined for Dr. Post, practically the same conclusion is reached. Moullin[8] records a similar observation.

These facts appear to show that just as some patients are not benefited by castration, so also will the prostate fail to show any change after the operation in a certain proportion of cases. That atrophy does occur in many instances has been fully established by microscopic examination.

The observation of Albarran[9] that "he has seen similar conditions to those pictured by Griffiths in cases that had never been castrated" (Cabot) is without weight as evidence that castration does not cause such changes. It has been already pointed out that at a certain age the prostate undergoes atrophy spontaneously.

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[1] J. William White: *Annals of Surgery*, July, 1895.

[2] *Separatabdruck der Mittheilungen aus den Grenzgebieten der Medizin und der Chirurgie*, verlag von Gustav Fischer, in Jena.

[3] *Annals of Surgery*, September, 1896.

[4] *Ibid.*

[5] *Brit. Med. Journ.*, March 16, 1895.

[6] *Loc. cit.*

[7] *Loc. cit.*

[8] *Lancet*, London, Nov. 30, 1895.

[9] *Ann. des Mal. des Org. Genito-urinaires*, Dec., 1895.

That castration is followed by atrophy of the normal prostate has been conclusively shown as an invariable result in the dog. In man it has been found that castration is followed by a true atrophy of the hypertrophied prostate in many cases, but not in all, and a much broader experience is necessary before we can predict with certainty those cases that will be benefited and those that will not.

Are the results due to rest in bed, hygiene, and other palliative measures? A study of the reported cases will show that in a large number of instances the patients have had the benefit of rest in bed, carefully regulated hygienic conditions, regular catheterization, irrigations of the bladder, and appropriate internal treatment with little or no relief. In fact, any one who has seen many of these cases must have observed that sometimes, in spite of the most intelligent palliative treatment, the condition of the patient gradually grows worse. It not infrequently happens that during this treatment catheterization is required more and more often and is attended with greater and greater difficulty, or it may even become impossible. Prostatic hypertrophy has been well known, and has been the subject of considerable study since Home wrote upon the subject in 1806. The palliative treatment, so far as it is understood at the present time, is well known to the profession. It is preposterous to accuse surgeons all over the world of such infidelity to their trust as to intimate that they have removed the testicles of their unfortunate patients at the first intimation of prostatic enlargement, without having first exhausted the ordinary measures at hand. There is nothing more certain than that the rank and file of the profession are conscientious in the discharge of their duties to their patients, and that they employ the best judgment at their command in dealing with the various accidents of disease and injury to which the human family is subject. Nor is it reasonable to suppose that all of the patients who have submitted to this operation have done so at the first intimation of urinary obstruction, without having ascertained that relief was not obtainable by simpler means.

The Factors that Bring about Decrease in the Size of the Prostate.—It has been asserted that the disappearance of symptoms following castration has been due to relief of congestion and edema of the prostate. This is probably true to a certain extent, but not, as some have supposed, on account of rest and other factors which would ordinarily obtain during confinement to bed.

The intimate relation existing between the testicles and the prostate has been thoroughly established both by the experiments already alluded to and by previous observations. The prostate being a sexual organ, the function of which is to secrete a fluid to dilute the semen, its activity would naturally continue during the functional life of the testes. Congestion doubtless is an important factor in the enlargement in the softer forms of prostatic hypertrophy. The removal of the testicles relieves this congestion by abolishing the source of the stimulus that excites the function of the prostate. This accounts for the very prompt and in some cases remarkable relief after operation. The later and final results, however, are due to a real atrophy of the gland, as has been shown by clinical experience, by post-mortem observations, and by numerous experiments on dogs.

Griffiths[1] and White[2] have shown that after castration it is the glandular tissue which first atrophies and disappears, and that this atrophy begins within a few days. The median lobe is particularly rich in glandular tissue, and as this is commonly the chief cause of the urinary obstruction, the early relief is thus accounted for. A very little diminution in the size of certain of these growths would suffice to bring about great relief of the obstructive symptoms. These factors also explain the ability to urinate soon after operation and the improvement in the symptoms that have been noted.

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[1] *Brit. Med. Journ.*, March 16, 1895.

[2] *Annals of Surgery*, August, 1893.

The Disappearance of the Hyperplasia.—The disappearance of the hyperplasia after castration has been remarkable. It is entirely rational to expect a diminution of the congestion after this operation, but that the newly formed muscle should disappear as well as the glandular elements is so surprising as to have led some writers to doubt its occurrence. It must be remembered, however, that the sole function of the muscular fibers of the prostate is to exert compression on the glandular tubules, the effect of which is to empty the contents of the latter into the urethra. The muscle fibers are entirely subservient in function to the glandular elements. The stroma of the prostate is as purely sexual as are the glands which it contains.

The number of observers who have witnessed reduction in the size of the prostate from that of a small orange to the normal dimensions or less is quite sufficient to establish its accuracy. Additional evidence is afforded by the microscopic examinations of the prostate of patients who have died after castration.

There can be no doubt that fibro-myomata of the uterus undergo atrophy after removal of the ovaries, and a consideration of the analogy between this operation and that of castration in hypertrophy of the prostate renders a similar result in the latter case quite comprehensible.

The Estimation of the Size of the Prostate Before and After Operation.—It would be desirable, for the sake of accuracy, to be able definitely to measure the prostate before and after operation, but this is of course impossible. To the average individual the comparison in size to that of a "walnut," a "billiard ball," an "orange," or a "fist," or the expressions "reduced to the normal size," "smaller than normal," "scarcely to be felt," etc., convey fairly intelligent ideas and for purposes of description answer at least for the practical surgeon.

The decrease in size can also be estimated by measuring the distance it is necessary to pass the catheter before urine flows both before and subsequent to the operation. This observation has not been made as frequently as it should have been, but in every instance in which the measurements have been taken a decrease in the length of the urethra has been noted. As the value of the operation is measured not by the amount of decrease in the size of the prostate, but by the relief afforded the patient, this question is one of minor importance, and is only discussed to meet the theoretical objections that have been offered by one or two writers.

The Relief of Cystitis.—Not the least interesting phenomenon in these cases is the disappearance of the intractable cystitis that is so often present. In the 111 cases reported by White[1] this occurred in 52 per cent. In his study of 148 cases Bruns[2] states that the aggravated cystitis so often met with is improved in many instances and often entirely cured. This result is explained by the fact that an important factor in the complications of prostatic enlargements is the pronounced congestion of the gland and vesical neck. From the prolonged backward pressure and passive hyperemia the veins become much distended and congestion or even inflammation of the mucous membrane of the bladder follows. The prostatic plexus of veins receives most of the return blood from the bladder, hence the relief of congestion in the former would be followed by a like result in the latter. It has been shown by the researches of a number of writers, prominent among whom are Guyon and Albarran, that in a healthy condition the mucous membrane of the bladder is able to resist the irritant effects of pyogenic bacteria in the urine. If, however, the resistance of the mucosa is lessened by the presence of congestion and by distention of the walls of the bladder, the same influence is apt to establish cystitis. The infectious microbes are carried into the bladder by instruments that have not been properly sterilized, or they are transferred from the anterior urethra at the time of catheterism. The micro-organism commonly found is the bacillus coli communis. Cystitis also develops independently of the use of instruments, but in one way or another is very apt to occur sooner or later in these cases. The decomposition of the mucus and other organic matters in the urine results in the breaking up of the urea and the formation of ammonium carbonate, which acts as a powerful irritant to the mucous membrane, but, as indicated, it is the result and not the cause of cystitis.

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[1] *Loc. cit.*

[2] *Loc. cit.*

We know that the tendency of healthy tissues is to resist the invasion of micro-organisms and their poisons, or to throw them off if they have already gained access. The most rational method of relieving an infected bladder, therefore, is to place it in as healthy a condition as possible. If the engorged vessels have an opportunity to empty themselves and the bladder to evacuate its contents regularly and completely, it is reasonable to suppose that the morbid process would be arrested, the mucous membrane would be restored to a healthy state, there would be no residual urine to undergo decomposition, and a cure would thus be effected. Fels and Ritter were able to produce cystitis in dogs by inoculating their bladders, but only on condition of ligating the urethra; upon loosening this ligature the bladder promptly resumed its condition of health.[1] The shrinkage of the prostate that follows castration seems to be the "loosening of the ligature" in the majority of these cases.

Diminution in the Length of the Urethra.—This is not brought about, as some suppose, by relieving an over-distended bladder. Finger's observations[2] show that the urethra is shortened when the bladder is overfull. In the cases in which the length of the urethra has been recorded the measurements before operation were usually taken with the bladder full, and after operation when it was comparatively empty, so that the decrease was actually greater than the measurements indicated.

Return of Vesical Contractility.—The return of power in the bladder is noted in 66 per cent. of the 111 cases first tabulated. The cases do not afford any information in regard to the particular class in which this may be expected. It occurred in some instances after several years of catheter life. Of 28 cases analyzed by Bruns,[3] in which the catheter was used for from some months to two years, natural, voluntary micturition was restored in 22. The improvement was usually observed in the first week. Of 20 cases in which the catheter life had lasted from two to twenty years, 8 have been enabled by the operation to discard the catheter entirely, spontaneous micturition having been restored.

Vesical Calculus as a Complication of Hypertrophy.—Among the classical contraindications to litholapaxy are a high degree of cystitis and enlargement of the prostate sufficient to interfere with the introduction of the necessary instruments. As the crushing operation is coming more and more into favor with the surgeons who have had most experience with it, a distinct advance has been made if we are enabled to remove the obstacles just mentioned. In one case recently under Dr. White's care castration was performed with a view of reducing the size of the prostate and of relieving the cystitis preparatory to litholaplaxy, which was done soon after, with the greatest satisfaction to the operator and to the patient. The patient was advanced in years and somewhat feeble. He was kept in bed but a few days after each operation instead of some weeks, which would have been necessary if cystotomy had been performed, and in addition it is quite probable that he will be more comfortable the remainder of his life by reason of having been relieved from the enlargement of the prostate to a greater degree than would have followed cystotomy. This experience was so successful that it was repeated in other cases, and will be resorted to in all appropriate cases in the future until a more satisfactory method of treatment shall have been described.

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[1] Keyes: *Am. Journ. Med. Sci.*, June, 1894.

[2] *Gonorrhœa and its Complications*, 1894.

[3] *Loc. cit.*

Permanency of the Results.—The successful cases among those tabulated in the *Annals of Surgery*, July, 1895, were grouped as to the time of report into three classes: (1) Those reported immediately after operation—that is, within the first two or three weeks, and from which nothing further has been heard; these comprised but 8.7 per cent. (2) Those in which from a month to three months elapsed before the patient passed from observation, and in which the prostatic changes and the improvement in symptoms were carefully noted; these amounted to 20 per cent. (3) Those observed after three months, and in which the local changes seemed to have reached their culmination and the health of the patient appeared to be permanently re-established; a total of 71.3 per cent. These figures, taken in conjunction with the knowledge of the manner in which the relief had been brought about, seemed very satisfactory. It is not reasonable to suppose that an organ which has once undergone atrophy would again rapidly enlarge. If it was a question of simply the relief of congestion, one could imagine a return, but it has been shown that castration is followed by a true involution of the prostate. We have, however, more recent evidence. Dr. Francis L. Haynes of Los Angeles, Cal., who performed the first castration for enlarged prostate in this country, reports that his patient remains well now more than two years after the operation. The condition of several cases has been reported between one and two years after operation. In this connection Dr. Cabot[1] has given important evidence. He says: "In the effort to obtain data upon this point I have written to the operators mentioned in Dr. White's table, whose cases were reported but a short time after operation. I received answers from twenty-seven out of forty-one addressed, and most of the reports were favorable."

Mortality.—In discussing this subject it will be necessary to take into account the feeble condition of these patients, the damaged kidneys which are so frequently associated due to the prolonged backward pressure, and the resulting infection. In the 111 cases referred to, which include nearly all of those operated upon up to the time of the report, counting all the cases that died after operation, the mortality is 18 per cent.; excluding 10 cases that clearly did not die from the operation, the legitimate mortality is 7 per cent. Even in most of the fatal cases a distinct amelioration of the urinary troubles was noted before death. It seems more fair to say that the operation failed to save life than that it was the cause of death. Barring the influence of the ether, castration *per se* should have an exceedingly small death-rate, but if the operation is performed on patients already in an advanced state of uremia or toxemia, with kidneys barely able to discharge the duty they have to perform, and entirely incompetent to withstand any additional strain whatever, a certain mortality must always be expected.

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[1] *Loc. cit.*

This proper revision of statistics has been objected to, but it is evident from the reports, and it is a matter of personal knowledge to the writers, that a number of these patients were castrated when on the verge of the grave, simply because the operation was so trifling and could be done in a few moments, with little or no ether, while any other operative procedure would not have been considered. For this reason it was and is proper to exclude from the estimates of mortality *due to the operation* many cases that were manifestly practically moribund when the testicles were removed.

Cabot says, following this line of thought, "It may be urged that the simplicity and ease of the operation have led some men to castrate patients so desperately ill that a more severe operation would not have been thought of. This is doubtless true; but we must remember that in the earlier days of prostatotomy and prostatectomy these also were looked upon as operations to which one must be driven by the extremest needs; and the first cases were therefore very unfavorable." But this is again an unfair comparison. It can scarcely be doubted that many cases have been subjected to castration that even in the earliest days of the other operations would have been considered too ill for operative interference.

This cannot be too strongly insisted upon if it is desired to obtain a fair comparison of castration with the various forms of prostatectomy.

The justice of this will be still more apparent when we consider the after-effects of the two operations. In the vast majority of cases of castration the patient may be allowed out of bed in from three days to a week, and the wounds will be healed in from seven to ten days. The patient would therefore be said to be "well" as far as the operation was concerned, and death due to accident or other causes after this time cannot be said to be due to the operation.

On the other hand, after prostatectomy the patient is obliged to remain in bed several weeks. Every surgeon is familiar with the various complications and the general break-down that frequently occurs in old patients from long confinement to bed, and an operation that requires this detention in such a class of cases will necessarily have a correspondingly greater mortality.

In Dr. Cabot's table of 99 cases 20 are recorded as having died (about 20 per cent.).

Among the fatal cases that have been charged to castration are:[1] "death due to uremia one year after operation." Another in which death occurred on the fifth day, "not as the result of the operation, but of the condition of the patient, which was very bad;" this was manifestly not a proper case for operation. One patient, aged eighty years, appears to have died of the changes inseparable from senility. He had frequently been "out of his head" before the operation, and was plainly not a case of which much could be expected from any form of treatment. In another case the surgeon operated against his own judgment at the urgent demands of the patient. Another patient, aged seventy-seven, is said to have developed senile dementia about a month after operation and died at the end of another month. The autopsy in one case revealed a right kidney three times the normal size and the left kidney the size of a hen's egg; the left ureter was occluded. Another is said to have died some days after operation of "chronic uremia," and was presumably uremic at the time of operation. In one instance a distinguished surgeon had advised against the operation. One patient died of perforation of the bladder and general suppurative peritonitis. This result could scarcely be attributed to castration by the greatest stretch of the imagination. One developed acute mania thirty-six days after operation. There were evidences of pyelitis in addition to great enlargement of the prostate and chronic cystitis. Another died of gangrene of the right leg "from occlusion of the popliteal," which could not have been due to the castration.

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[1] Cabot: *Annals of Surgery*, Sept., 1896.

In endeavoring to arrive at the true mortality of castration in properly selected cases, in contradistinction to that of the operation in cases that are too far advanced to admit of any other form of treatment, or who are *in extremis*, most or all of the cases mentioned may be legitimately deducted from those who died as a result of the operation. Deducting those cited, the mortality in Dr. Cabot's table would be 10 per cent. instead of 20 per cent.

We have collected 107 cases of castration, not included in the tables of White or Cabot. The number of deaths were 12 (11 per cent.). They were as follows: exhaustion 3; 1 became septic from his pyuria and died, but was improved by the operation; 1 died on the twenty-second day of pyelonephritis; 1 died of surgical kidneys—the reporter says the patient "should not have been operated upon;" 1 died on the fourth day of suppression of urine; 1 had a perineal section for drainage three weeks after castration—the cause of death could not be determined; 1 died of cerebral hemorrhage; 1 of fatty degeneration of the heart; 1 died five or six weeks after operation—there were infection of the wounds and secondary deposits; the autopsy showed pyelonephritis; 1 was subjected to suprapubic lithotomy one week after castration, and died eight days later.

It is clear that in estimating the mortality of this operation several of these cases must be thrown out—the 2 cases subjected to a second serious surgical attack and the patient who died of cerebral hemorrhage. This reduces the mortality to 8.5 per cent. If the cases had been *carefully selected*, the figure would be below 5 per cent. We desire to emphasize this point. Before operating for carcinoma, for example, every aspect of the case is considered. If it is thought that the patient will not survive the operation, the surgeon very propery declines to interfere. Mark the difference in many cases of hypertrophied prostate. The patient has absolute retention, catheterization is very difficult, and is followed by profuse hemorrhage; the patient is nearly exhausted from suffering, loss of sleep, etc.; he is probably septic, he begs for relief; the surgeon advises castration, as it is a minor operation. The patient does not recover; the mortality is raised. This is not a proper basis from which to judge any surgical procedure.

In a few cases some form of nervous disturbance is reported to have followed castration. Surgeons have long been familiar with a form of mania which, for want of a better term, may be called "post-operative," that sometimes develops after any form of operation. In our personal experience we have not observed any permanent mental change after castration. We are inclined to accept the view of Hughes[1] that "the causes that made the operation necessary of themselves lead to degenerative changes in the nervous system, and of course the psychical effect of the surgical procedure must be considered." He states that the chief causes of these disturbances at this time seem to be "constitutional neuropathic decadence and hereditary neural instability."

It is true the question of "mania" or other mental disturbance as a remote result of the removal of the testicles must be considered. It seems, however, that those who see in mania after castration the relation of cause and effect have not made out their case. Some of these patients are said to have been "out of their heads," "subject to such spells," "mental condition feeble," "patient in a peculiar mental state for a long time," etc., before the operation. This is doubtless due in most cases to degenerative changes in the coats of the arteries—an arterio-sclerosis—which results in softening of the brain, renal insufficiency, and degeneration of the viscera generally. One patient is said to have developed "acute hysteria," one became melancholic, another unconscious on the eighth day and died on the fourteenth day. One patient was excessively nervous and begged for the operation. After operation he "remains nervous and despondent." The mental condition noted in some of these and in other cases was due, in all probability, to the previous condition of the patient, to suppuration of the wounds and the accompanying fever or septic absorption, or to uremia. Certainly none of the cases so far described show conclusively that there is a liability to any peculiar change of the mental condition after castration. Besides, the following facts negative this idea: Castration in earlier life, when the individual is still in good health, has not been observed to cause any change in the patient; oöphorectomy is not followed by mental deterioration except in the rarest instances, nor is castration in animals.

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[1] *Kansas City Med. Index*, xiv. 1893.

In a discussion on "The Relation of Nervous Disorders in Women to Pelvic Disease," Weir Mitchell says:[1] "Both Goodell and I have long suspected that insanity after operations is sometimes due to the anesthetic, since twice we saw it follow operations of quite a trivial nature."

Albarran,[2] who has carefully studied the effects of castration in enlargement of the prostate, discusses the results of the operation from the double point of view of the size of the gland and the contractility of the bladder:

I. *Effect of Castration on the Volume of the Prostate.*—There is in most cases a true atrophy of the gland demonstrable by rectal examination. Sometimes this progresses until the gland becomes very small in size; in other cases the decrease in size is less marked; occasionally atrophy does not seem to occur at all, or takes place after some weeks. Albarran observed a case in which no change had occurred at the end of a month, but a marked decrease in size had taken place at the end of four months.

Immediately after the operation there is always the relief afforded by the decrease in the congestion of the parts, which occurs also, as Guyon has pointed out, after bilateral section of the vasa deferentia. Of itself, alone, congestion can increase the size of the prostate at least a third. The lessening of congestion causes diminution in the size and consistence of the prostate and frequently relieves the urinary symptoms a few hours after the operation.

II. *Effect of Castration on Vesical Contractility.*—The relief of the congestion seems to give new power to the bladder muscles. This is, according to Albarran, the explanation of spontaneous urination in one of his own cases four hours after operation, when it had been impossible for six months before; in Eastman's case after twelve hours, after having retention for a year; and in Horwitz's case after retention for five years.

Castration acts differently on vesical contractility according to the case.

(*a*) In hypertrophied prostate with dysuria, but without retention, the frequency of urination at once diminishes. In 13 cases this improvement came in the first two days, though sometimes it was delayed for a week to two weeks, and in one case for five weeks. In but one case was the function of urination unimproved six weeks after operation. There has been no recurrence in the cases observed by Albarran, though one patient was seen fifteen months after operation.

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[1] *University Medical Magazine*, March, 1897.

[2] *Annales des Maladies des Org. Genito-Urin.*, Dec., 1895.

(*b*) Hypertrophy with acute retention. In these cases relief comes from diminution of the congestion. In 13 cases one urinated spontaneously at the end of eight hours; the others after two or more days, just about as in the cases of this kind treated by catheterization alone.

(*c*) Hypertrophy with incomplete retention of urine. Here not the lessened congestion, but the gradual diminution in the size of the prostate, brings relief. Vesical tone gradually returns. In a case in which observations with the manometer were made before the operation, 300 grams of liquid were injected before reflex contraction of the bladder was aroused, and then the contraction lasted but a very short time. Three months after castration manometrical observations showed that 180 grams sufficed to cause the bladder to contract, and the contraction was vigorous; the force increased gradually as more liquid was injected.

In 24 cases of this class operated upon there was one death. All the others have had a notable amelioration of symptoms.

(*d*) Hypertrophy with complete chronic retention of urine. In these cases, after castration, there may be extremely rapid improvement, and even complete cure, which shows that there has been but little sclerosis of the vesical muscle. In one of Albarran's cases of this kind the prostate could not be felt by the finger in the rectum four months after the operation. Though there have been a number of deaths in patients of this class, they have been due, not to the operation, but to the preceding infection of the kidneys consequent upon the accumulation by stasis of urine in the bladder.

With regard to the mortality, Albarran finds 22 deaths in 135 cases (16 per cent.), but thinks this large mortality ought not to deter operators *in properly selected cases,* as in most of the fatal cases death was inevitable anyhow.

"There are," he says, "in surgery, general contraindications to every operation of any gravity. If these had not been neglected this lamentable mortality need not have resulted." As to precise indications for castration in hypertrophied prostate he would hesitate to speak. The question is open for study. At present he would not operate in cases of dysuria without retention nor in acute retention, but would treat them by the ordinary methods. He would suggest it in chronic retention, complete or incomplete, when catheterization does not suffice to cure or the passage of the catheter is habitually difficult.

The operation will have its best chance of success when manometric examination of the bladder shows that the vesical muscles still retain their contractility, although it may prove that this contractility has been considerably lessened and is not very persistent in its action.

Removal of One Testicle.—The objection to castration met with in a certain proportion of cases, whether from sentiment or from the fact that the testicles have not lost their function, has led to the suggestion of removing one testicle only. The evidence regarding the value of this procedure is conflicting. Fenwick[1] reports 20 cases in which one testicle was undescended, had atrophied, or had been removed. The examination of the prostates in these cases did not show any constant results. In some cases the lobe of the prostate corresponding to the testicle which had atrophied or had been removed was equal in size and consistence to that of the opposite side; in some cases it was smaller, and in others larger than its fellow. The same statement applies to other cases that have been reported. There have been fewer observations in cases of hypertrophy of the prostate. The reports seem to show, however, that in a certain proportion of cases the removal of one testicle will be followed by a reduction in the size of the corresponding lobe of the prostate, or of the entire gland. In a personal communication[1] Dr. Horsley of Staunton, Va., reports having removed one testicle on account of a cystic condition in the case of a man who was also the subject of enlargement of the prostate. A rectal examination at that time showed that the prostate was considerably enlarged. The patient was obliged to rise several times during the night, and he complained of dysuria. Three months after the operation the prostate gland was found to be considerably smaller, particularly on the left side. The patient also reported that he had very little trouble in urinating, and as a rule did not have occasion to empty the bladder after bedtime.

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[1] *Brit. Med. Journ.*, 1895.

Euren has[2] had very good results from the ablation of a single testicle in cases of prostatic hypertrophy. In patients under seventy years of age, and in whom urinary retention is not extreme, he thinks that the removal of a single testicle selected, if possible, with due reference to the lobe of the prostate that most interferes with urination, may suffice. He performs this operation under local cocaine anesthesia. In two of his cases digital examination *per rectum* some time after operation showed that the half of the prostate corresponding to the removed testis was softer and smaller than that of the opposite side.

Whether removal of a single testicle will induce atrophy of median enlargements is still an open question. This portion is probably equally influenced by each testicle. A case in point is reported by Moullin:[3] The patient was nearly sixty years of age, and to all intents and purposes a monorchid. Shortly after birth the left testis had been subject to a proceeding similar to bistournage and had wasted in consequence. The patient complained of symptoms characteristic of median valvular enlargement of the prostate. The residual urine amounted to 10 or 12 ounces. As long as the patient was lying down and made no particular effort, micturition was easy. If he stood upright, and especially if any vigor was thrown into the attempt, the stream would stop abruptly. Examination by the rectum showed but little change in the apparent size and relations in the prostate. The prostatic portion of the urethra was more than two inches in length, and a metal catheter could not be passed without depressing the handle to a very considerable extent. A median perineal urethrotomy was performed and a pedunculated growth nearly the size of a pigeon's egg was found hanging in the orifice of the bladder and acting like a ball valve.

The removal of one testicle has the merit of being less objectionable to many patients than removal of both testicles, and from past experience we may expect sufficient relief in a fair proportion of the cases. To obtain the best results the conditions should be carefully studied with the view of determining the side upon which to operate. In case of failure we may still operate upon the other side.

Operations upon the Vas Deferens.—In the discussion that followed the proposition to remove the testicles for the relief of the conditions incident to hypertrophy of the prostate, a number of suggestions were offered as a substitute in order to avoid the sentimental objection to the operation of castration. Among these may be mentioned ligation or section of the vasa deferentia, section of the nerves of the cord and ligation of the arteries supplying the testicles. The most important of these are the operations upon the vas. It appears, however, that the procedure was not entirely new. R. Harrison reports[1] having divided the vasa deferentia in a case of prostatic enlargement as a compromise for castration, which the patient had earnestly requested. The patient is said to have been alive and well six or seven years later. It seems strange that this very happy outcome of so simple an operation should have passed unnoticed until the present time, particularly in view of the fact that we had no satisfactory means of affording relief to this large class of sufferers.

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[1] *University Medical Magazine*, March, 1896.

[2] *Upsala Läkareforenings Forhandlingar*, Dec. 23, 1895.

[3] *Lancet*, London, Feb., 1896.

In 1894, in a series of experiments on dogs, the vasa were ligated or divided with the view of determining the effect upon the normal prostate.[2] The results show that there was a constant loss of weight in the prostate of every dog that died eight days after the operation or later. In the dogs that were kept alive for fifty-two days the atrophic changes were unmistakable. These results were obtained without any particular change in the testicles, so far as could be observed.

The experimental evidence on this subject is somewhat conflicting. Curling[3] concludes from his studies that obliteration of the vasa, whether congenital or the result of disease or other lesion, does not as a rule affect the development of the testicles. Griffiths[4] found, after ligating the vasa deferentia in young dogs, that the testicle developed normally, and after a passing swelling of the epididymes did not show any changes in structure or in the production of spermatozoa. Legueu,[5] after ligating the vasa, did not observe any change in the testicles at the end of from two to five months. Przewalski[6] has arrived at the same conclusion.

These observations are in accord with the experiments above referred to.[7] On the other hand, Alessandri[8] in similar experiments observed atrophy of the testicle and epididymis. The parenchyma showed fatty degeneration and connective-tissue overgrowth.

Burnett[9] observes that obliteration of the ejaculatory ducts happening in childhood causes arrest of development of the prostate and seminal vesicles, without affecting the testicles. In support of this he cites the case of a man thirty-five years of age upon whom lateral lithotomy had been performed thirty years before. The ejaculatory duct was injured at the time and became closed from cicatricial contraction. The testicles were found to be normal and the sexual power was not affected, but there was no discharge of semen. The seminal vesicles could not be felt, and the prostate was said to be smaller than would ordinarily be found in a boy ten years of age. Pavone[10] reports the result of his experiments on dogs with removal of one and of both testicles and of bilateral ligation and resection of the vasa deferentia. He observed atrophy after all three procedures; in conclusion, he recommends ligation and excision of the vasa for prostatic hypertrophy.

Przewalski[11] concludes from his experiments on dogs that the effect produced on the prostate by these operations is brought about by the division of Cooper's nerves, which were accidentally severed in the course of the operation. He states that the double-sided section of the *plexus deferentialis*, either with or without section of the vasa deferentia, caused atrophy of the prostate.

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[1] *Brit. Med. Journ.*, Sept. 23, 1893.

[2] *Annals of Surgery*, July, 1895.

[3] *Diseases of the Testicles*, London, 1866.

[4] *Lancet*, April 13, 1895.

[5] *Semaine méd.*, No. 52, 1895.

[6] *Vrach*, Nos. 41 and 43, 1895.

[7] White: *loc. cit.*

[8] *Il Policlinico*, No. 9, 1895.

[9] *Journ. Cut. and Genito-urin. Dis.*, No. 9, 1895.

[10] *Il Policlinico*, No. 11, 1895.

[11] *Vrach*, Nos. 41 and 43, 1895.

The particular method of dealing with the vas, whether simple ligation be performed, or ligation with division, or double ligation with resection, seems to be a matter of indifference as far as the result is concerned. Helferich practised evulsion of the vasa, but gave it up as an unnecessarily violent procedure.

In all of these cases the symptoms have been more or less relieved, and in some to a marked degree. Bruns[1] has analyzed 11 examples with the following results: In 4 there was decrease in the size of the prostate after three, six, and eight weeks. In 2 the gland was reduced to one-half the size it was before the operation, and in 1 case could not be felt. In 3 instances no change was noted in the size of the prostate at the end of two months, but there was an improvement in the function of the bladder. The urinary symptoms were cured in 2 cases, although no change in the prostate was noted. Finally, in 2 cases no change whatever was observed.

We now have records of some 100 cases of operations on the vas for prostatic hypertrophy. Of these, 8 died (8 per cent.); 59 (59 per cent.) are said to have been more or less improved; in some cases complete relief was experienced. In 21 cases (21 per cent.) the prostate is said to have become smaller after the operation. The testicles were found to have undergone atrophy in a few cases only.

The results in the cases collected by Pavone[2] and Herhold[3] are better than those just given. The former reports 34 cases: of these, 4 (12 per cent.) died, 2 (6 per cent.) were not benefited, and 28 (82 per cent.) were cured or improved. Herhold adds 3 cases to 41 previously reported. Of these, 30 (70 per cent.) are said to have been entirely relieved of their troubles. Drézigni records[4] having performed resection of the vasa deferentia in 22 cases, with notable improvement in each case.

It will be seen that the mortality after this operation is about the same as that after castration, while the chances of relief are less. Vasectomy should be advised in certain cases in which castration is refused, and in those of the milder type as the best alternative.

The only untoward result that has been recorded was a troublesome and imperative desire to urinate, accompanied with severe pain and tenesmus, in the beginning of the improvement, in one of Helferich's cases. This was also observed in two of Dr. White's patients. It disappeared gradually in both.

A few cases of mental disturbance have been observed after vasectomy; all recovered, however.

The advantage that vasectomy offers is one of sentiment in those cases that object to castration. Against this possible advantage there is the probability that the same benefit will not be secured as would be followed by castration, and the relief is less rapid. Guyon says of excision of the vasa: "Although this operation cannot pretend to affect a radical cure of hypertrophy of the prostate, as does that of total castration, yet it may take rank among those measures addressed to certain complications of prostatism." Wider experience leads us to recommend the operation with more confidence than at first seemed justified.

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[1] *Separatabdruck der Mittheilungen aus den Grenzgebieten der Medizin und der Chirurgie*, verlag von Gustav Fischer, in Jena.

[2] *Il Policlinico*, No. 15, 1896.

[3] *Deutsches med. Woch.*, June 14, 1897.

[4] *Bull. méd.*, Jan. 3, 1897.

Operation.—The vas is so superficial and so easily reached that it may readily be exposed by means of local anesthesia secured by hypodermic injections of cocaine, by the Schleich method, or by the spray of ethyl chloride. The vas will be recognized by its cord-like hardness when rolled between the finger and thumb before operation, and by its white, glistening appearance after making the incision. In the present state of our knowledge it does not seem to be a matter of importance just how the operation is concluded if the canal be obliterated. Some employ a simple ligature, others divide the vas between two ligatures, and still others remove a greater or less portion of the duct after having tied it on both sides.

Isnardi,[1] who has performed this operation in 14 cases, believes that the failure to secure beneficial results is due to the fact that after the ligation and section of the vas obliteration of the distal stump does not occur, which he thinks it is necessary to secure in order to bring about atrophy of the prostate. He therefore recommends that the distal end of the divided vas be fixed in the skin wound and cauterized repeatedly (on the third day with 1 per cent. nitric-acid solution to set up a funiculitis).

Harrison adopts the following method :[2] " The scrotum having been shaved and prepared antiseptically, the tube is carefully sought for as it enters the scrotum. It is then held subcutaneously in position between the finger and thumb ; a vertical incision through the skin is made over it to the extent of an inch or so. The spermatic cord having been recognized, the vas is separated from the other constituents by the finger and probe by merely carefully teasing away the connective tissue about it. In doing this care should be taken not to drag on the testicle too much, but to support it whilst a loop of vas is detached, so that the connections of the former may not be loosened. The vas should be well cleared of all other tissues, and then a loop is gently drawn through the wound with a blunt hook. The loop is next encircled below the hook with a silk ligature, which is tightly knotted. The ligature is cut short, the extraneous portion of the vas removed by scissors, and the pedicle dropped into the wound, which is closed with one or two sutures."

In performing vasectomy we have found it convenient to isolate the vas from the other structures of the cord by manipulating between the fingers and thumb and thrusting a hare-lip pin through the scrotum beneath the vas, which is thus fixed and does not escape in the succeeding steps. It is thus possible to operate through a one-quarter or one-half inch incision.

Miscellaneous Operations upon the Cord.—With the view of exhausting this line of thought as nearly as possible, the effects of other operations upon the cord have been studied.[3]

In a series of dogs all of the structures of the cord were ligated, and, in addition, in some instances divided between two ligatures. The testicles, as might have been expected, sloughed in almost every instance. The prostate was found to have undergone atrophy without exception, the changes being as unmistakable as though primary double castration had been performed. It is possible that sloughing would not be so constant after this operation in the human subject, as the details of asepsis and of the after-treatment of the wound could be so much better regulated than in the case of dogs. It is certain, however, that sloughing would be very commonly met with. The venous and lymphatic channels both being obliterated, absorption could not occur, as the testicle underwent atrophy and moist gangrene would result.

The same remarks apply, but to a less extent, to ligation of the vascular structures of the cord. The possibility of sloughing of the testicles would be present in every case. Beneficial results may be expected if atrophy of the testicles can be secured, but it would be impossible to tell in a given instance just how many vessels could be ligated without endangering the vitality of the testicles.

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[1] *Semaine méd.*, No. 64, 1895.

[2] *Lancet*, London, Feb. 22, 1896.

[3] White : *loc. cit.*

The value of the division of the nerves of the cord is still an open question. A series of observations were undertaken with the view of determining this point, but it was found that the nerves in the dog were so small and difficult to find that the idea was abandoned. Some writers, among whom is Przewalski,[1] believe the effect upon the prostate of the various operations described is due to the division of Cooper's nerves. He claims to have secured atrophy of the prostate in dogs after resection of these nerves. The result seems to have been as pronounced in the cases in which he performed the simple resection of the nerves as in those in which the vas deferens was divided in addition. The subject needs further investigation. At present it can only be said that with the much greater security of beneficial results following one of the operations upon the vasa deferentia the latter should be selected if for any reason castration is declined by the patient or, is in the opinion of the surgeon, undesirable.

Ligation of the Internal Iliac Arteries.—The fact that ligation of the uterine arteries was sometimes followed by atrophy of fibroid tumors of the uterus led Bier[2] of Kiel to practise ligation of the internal iliac arteries for hypertrophy of the prostate. Although Bier's cases were improved by the operation, the result is obtained at too great a cost. In the first case the operation was attended with a great deal of difficulty and consumed considerable time. The patient died of septic peritonitis on the third day after the operation. Although the operation was said to have been easily performed in his subsequent cases, it must be admitted that difficulty would occasionally arise. Surgeons generally have not been willing to perform this operation.

Further, the operation is not parallel with that of ligating the uterine arteries for fibro-myomata, for in this case simply the blood-supply to the affected part is cut off, while in the ligation of the internal iliac arteries the vessels going to important structures beside the prostate are obliterated.

Meyer[3] has performed this operation in 3 cases with the following results: "One patient was only partially improved, one died of unknown cause seven days after the operation, and the third has not been improved at all."

The author believes, however, that the operation has a field of usefulness. He prefers the extra-peritoneal method. He adds: "In view of the brilliant functional results after castration, also after resection or division of the vas deferens, I should say to-day, 'Bier's operation seems to be indicated only in patients below the fiftieth to sixtieth year with absolute retention due to the hypertrophied prostate, who are tired of catheter-life, but refuse to lose one or both testicles, and are unwilling to become sterile, in spite of the probability of an otherwise undisturbed power of sexual intercourse.'"

Resume.—In the early stages of prostatic hypertrophy, when there is slightly increased frequency of micturition, which may be either nocturnal, diurnal, or both, some hesitation in starting the stream and diminution in its force, in conjunction with moderate enlargement as detected by rectal examination, it is sufficient to place the patient upon a proper diet, and to regulate the habits so as to avoid, as far as possible, all conditions which give rise to

[1] *Vrach*, Nos. 41 and 43, 1895.

[2] *Wiener klin. Woch.*, No. 32, 1893.

[3] *Annals of Surgery*, June, 1896.

prostato-vesical congestion. In addition, the introduction of full-sized steel sounds once or twice weekly for a long period should be recommended. The latter has seemed in many cases to relieve the mild symptoms of the early stages of enlarged prostate and to postpone for a long time at least further trouble. Small doses of ergot, continued for a long period, will be useful in certain cases by reducing the prostatic congestion, and strychnine should be administered to tone up the vesical wall.

If, in addition to the symptoms already mentioned, or if they are present in a more aggravated form together with three ounces or more of residual urine, regular catheterization should be employed in addition to the measures already described. The frequency will depend upon the amount and the character of the residual urine. If the urine be sterile, the catheter should be used once daily if the quantity amounts to three ounces, twice daily for six ounces, and once more for each additional two ounces. If there be cystitis with ammoniacal urine, the irritability of the bladder may require the more frequent use of the catheter. In these cases it is well, after drawing off the urine, to irrigate, at least two or three times a day, with some antiseptic fluid —viz. boric-acid solution, 10 grains to the ounce; silver nitrate, beginning with 1 to 10,000 and gradually increasing the proportion; corrosive sublimate, beginning with 1 part to 50,000 and cautiously adding to the strength; or potassium permanganate, beginning with 1 to 10,000. The bladder will be found to become more tolerant to these remedies after they are used for a time, and as there is in some cases an idiosyncrasy, it is better to err in the direction of having the fluid too weak than too strong.

If this treatment has been carefully carried out without relief, or if the frequency of urination increases, if the cystitis grows worse, and particularly if the introduction of a catheter becomes more and more difficult and painful, some form of radical treatment will become necessary if we wish to prolong the life of the patient. We have to select between prostatotomy, or simple bladder drainage, some form of prostatectomy, and castration or one of its substitutes. We are not yet in a position to dogmatize in this matter. The particular conditions present will usually indicate one or other of the procedures mentioned. We believe that the fields of prostatotomy and prostatectomy have become very much restricted during the last two or three years. If we are satisfied that we have to deal with hypertrophy confined principally to the so-called "middle lobe," and if the condition of the patient is such as to warrant incurring the risk of a major operation, suprapubic prostatectomy would be, theoretically, the operation of choice. The mortality of this operation, according to the most recent statistics, is about 20 per cent.

If the lateral lobes are prominently enlarged, they cannot be dealt with in this way, and the combined suprapubic and perineal operation seems an unnecessarily severe attack when we have at command less serious and more efficient means. The simplest of these, and that which we believe we are justified at the present time in advising, is ligation or excision of the vasa deferentia. This of course would render the person sterile, but that could hardly be urged as an objection at the time of life at which prostatic hypertrophy is met with. It would be entirely proper, if the condition of the patient was not too urgent, to operate on one side only, as has been recommended by Mr. Reginald Harrison,[1] when if the symptoms do not improve the procedure may be repeated on the opposite side. This method would be particularly applicable if it could be determined that one side of the gland was more enlarged than the other.

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[1] *Lancet*, London, Feb. 22, 1896.

In more advanced cases, in which it is necessary to secure relief without delay, or if the last-named operation has failed to give relief, castration offers by far the best chance of bringing about a rapid and permanent amelioration of the urinary symptoms. In comparison with prostatectomy castration has a lower mortality, the proportion being as 20 to 7.1 In addition, the relief after castration and the return to the normal, local, and general conditions have been, in the successful cases, much more rapid and complete than after prostatectomy. The convalescence from the operation occupies a much shorter time; the annoyance of a urinary fistula which may become permanent is avoided; and relapse after castration has been recorded much less frequently than after prostatectomy.

As was mentioned in speaking of the previous operation, if the age of the patient or other conditions makes the removal of both testicles objectionable, the operation may be done on one side only. This has been particularly urged by Euren.[1] In 3 patients so operated upon the results were entirely satisfactory. In a fourth case it was necessary to remove the second testicle before relief was afforded. Euren thinks, however, that if, in this case, the last testicle had been removed first, a satisfactory result would have been obtained without the second operation. Digital examination per rectum showed in 2 cases atrophy and a softer consistence on the side of the prostate corresponding to the testicle removed. He performs the operation under cocaine anesthesia. He believes with Esmarch that these patients should be kept at rest for about a month before active exercise is allowed, in order to secure proper involution of the prostate.

Finally, if the patient is sixty-five years of age or older, and if the obstruction is complete or nearly so, if catheterization is very difficult, and if there is a high degree of cystitis, castration is undoubtedly the operation of choice.

Fenwick[2] concludes that double castration will prove of value in the following conditions: (1) In reducing bulky overgrowth of the lateral lobes of the prostate: it may be found that the small tough fibrous median or lateral vesical outgrowths will be better removed by suprapubic prostatectomy; (2) in controlling the distress and danger of an inflamed, senile, enlarged prostate; (3) in lessening the frequency or difficulty of introducing the catheter in advanced or confirmed catheter-life; (4) in avoiding the mechanical difficulty of crushing a post-prostatic or a post-trigonal stone by levelling the base of the bladder, thus rendering the operation of litholapaxy feasible in a condition in which before it was impracticable; (5) in reducing chronic cystitis and recurrent phosphatic calculus in cases of confirmed catheter-life.

Tuberculosis.—Tuberculosis of the prostate is said to be always secondary to deposits in some other portion of the genito-urinary system. Marwedel has contributed a very valuable article on this subject,[3] in which the following statistics appear: In 35 cases of uro-genital tuberculosis the prostate was found affected 26 times (Simmonds); in 27 cases, 18 times (Oppenheim); in 15 cases, 14 times (Krzywicki); in 70 cases, 44 times (Collinet).

Rokitansky believes that as a rule tuberculosis of the prostate and seminal vesicles is secondary to deposits in the epididymis. From the prostate and seminal vesicles the disease involves the urinary organs, perhaps extending to the kidney. Virchow appears to favor the theory of the ascending involvement of these organs. Klebs has met with no case in which a descending extension could be shown. On the other hand, Cohnheim claims that uro-genital tuberculosis is a descending disease—a disease of elimination; the virus, he states, is discharged through the glomeruli and may attack any point, but most frequently the pelvis of the kidney is affected. The disease, he claims, extends from the prostate to the testicles. Steinthal agrees with Cohnheim that uro-genital tuberculosis starts from the kidneys.

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[1] *Upsala Läkareforenings Forhandlingar*, Dec. 23, 1895.

[2] *Brit. Med. Journ.*, March 16, 1895.

[3] *Zeitr. z. klin. Chir.*, Tübing., 1892, ix.

Orth says that in the majority of cases of tubercular disease of the testicle the infection has spread from the prostate and seminal vesicles. Weigert supports the view that tuberculosis is an ascending process, beginning either in the testicle or the prostate. Simmonds believes the epididymis is the point primarily involved. Orth admits an ascending infection; he states, further, that uro-genital tuberculosis very seldom begins in the prostate. Krzywicki states that his study leads him to believe that the prostate is mostly the central point from which the disease disseminates itself. He describes 15 cases in support of his view, in 14 of which the prostate was the seat of tubercular disease. The primary location in the prostate was shown by the presence of old cheesy deposits, while in the other organs the process was more recent. He points out that the prostate must play some rôle in uro-genital tuberculosis, either in its genesis or in the transfer of the disease from the genital to the urinary system or *vice versâ.*

Uro-genital tuberculosis is, in the majority of cases, secondary to deposits in the lungs or in the osseous system; according to Hjalmar Heiberg, it is most often associated with the latter. Jani has found tubercle bacilli in the healthy prostates of phthisical patients. Given a tubercular patient, therefore, and a prostatic trauma, with a resulting *locus minoris resistentiæ,* a tubercular inflammation is apt to develop. Gonorrhea may be in this manner an exciting cause.

A prostate the seat of tuberculosis may contain one or several cheesy foci, which may later break down and form an abscess, or in some cases the more fluid portion is absorbed and the resulting mass is encapsulated. In some cases the cheesy deposit becomes the seat of calcareous change and the lesion heals. Broca has reported a case in which nearly the whole of the gland thus became a calcareous mass. Klebs and Krzywicki claim that distinct miliary involvement of the prostate has never been shown, although it would seem that such might occur.

The disease is usually manifested by circumscribed cheesy collections or an abscess of the prostate. In the case of small abscesses it is possible that the pus might find its way out of the ducts of the glands. Larger abscesses are apt to break through the capsule and empty into neighboring organs, with the formation of fistulæ. The most frequent direction seems to be into the urethra, and next toward the perineum. Several cases are reported in which the abscess opened into the rectum; cases are on record in which the pus discharged above the pubis. Socin described a case in which the abscess opened into the abdominal cavity. Perforation upward behind the vesical sphincter is more frequent. In the late stages of tuberculosis of the prostate the bladder becomes extensively involved, as do also the seminal vesicles. The prostate is usually enlarged in these cases. Réclus describes a tuberculous prostate 64 mm. in diameter. Socin places the average maximum diameter at 44 mm. Lancereaux speaks of a case in which the gland was enlarged to five times its normal size. In rare cases there may be some diminution in size.

Symptoms.—This subject has not received the attention its importance deserves. Thompson devotes but a brief space to its consideration, and he denies that tuberculosis of the prostate presents a characteristic symptom-complex. Perhaps one-third of the cases are either free from symptoms, or the inconvenience is so slight as not to attract the attention of the individual.

The first symptoms usually described are those belonging to a catarrhal prostatitis. There is slight irritation of the bladder, some increased frequency of urination, which is attended by burning pain; there is a sense of weight or of pain in the perineum: pain in the back and in the glans penis. There may be a muco-purulent discharge from the urethra. The disease usually occurs in anemic persons already the subjects of tuberculosis elsewhere. It may, however, develop in strong, apparently healthy individuals.

It is impossible to make a diagnosis in the early stages of the disease. The discharge is apt to be attributed to urethritis. Fever may be a late symptom, and may rapidly be followed by abscess and retention of urine. Englisch points out that tuberculous individuals are predisposed to urethral discharge. Tuberculosis of the prostate does not appear to be accompanied by the peculiar mental depression that is frequently observed in chronic inflammation of this organ.

The disease begins, in the majority of cases, between the twentieth and forty-fifth years, which corresponds to the greatest activity of the genital apparatus, but pronounced cases have been observed in childhood and in old age.

Diagnosis.—A number of writers have called attention to the similarity that exists between the symptoms of prostatic tuberculosis and of vesical calculus. A consideration of the symptoms and the use of the sound will lead to a correct diagnosis. Hematuria may raise the question of a malignant tumor of the bladder or prostate. The presence of tubercular deposits in other portions of the body, the condition of the urine, and particularly if the latter contains tubercle bacilli, will usually be conclusive. In old age it may be attributed to simple prostatic hypertrophy, but the condition of the seminal vesicles, epididymes, etc. will materially assist in arriving at a conclusion. The tubercular nodule in the prostate is more circumscribed than is observed in simple enlargement. The absence of tubercle bacilli in the urine must not be considered as conclusive evidence that the disease does not exist. Guyon states that in cases of undoubted tuberculosis of the urinary organs examination fails to detect the bacilli in 50 per cent. of the cases. Marwedel claims, however, that in his cases the bacilli were found in every instance. The tubercle bacillus must be distinguished from the smegma bacillus, which has the same resistance to acids. It may be necessary to draw the urine carefully with the catheter or to make inoculations in guinea-pigs. The course of the disease depends upon the strength of the individual; usually the patient succumbs sooner or later to the local disease or its complications, or to general tuberculosis. That the disease may run a slow course is shown by the case of Mitscheilich's, in which the latent stage lasted sixteen years, the disease being relighted by an attack of gonorrhea. The prognosis is not entirely hopeless, even after fistulæ have formed. A local and general cure is sometimes possible, usually, if at all, through surgical measures.

Treatment.—The disease can be best avoided by guarding against an attack of gonorrhea or other influences that would induce a congestion or inflammation of the prostate. The general condition of the patient will usually require careful attention. Any indication for treatment that may exist is to be met with appropriate measures. In regard to the local affection authorities differ: some refrain almost entirely from local treatment. On the other hand, Berkeley Hill has introduced iodoform into the bladder and speaks enthusiastically of its value. His formula is as follows: Iodoform, 2 parts; mucilage of gum arabic, 4 parts; glycerine, 2 parts; water, 20 parts. After washing out the bladder a dram of the mixture is introduced. The applications cause considerable pain, for which Hill recommends the use of cocaine or even ether narcosis. The omission of the glycerine was found to lessen the pain following the application. In some cases symptoms of iodoform-poisoning were noted. Balsam of Peru, in 2 to 3 per cent. emulsion, also acted well, and was found to be efficient in relieving the cystitis. Von Dittel has used iodoform, but without result.

It is important to avoid as far as possible all local irritation. Therefore, the use of urethral instruments must be discontinued or very carefully and infrequently employed.

It has been the custom to delay operation in cases of tuberculosis of the prostate as long as possible. In the light of our present knowledge of tubercular processes it would seem that earlier interference should be the rule. It is reasonable to suppose that a fair proportion of localized deposits in the prostate would heal up if removed with the curette and if proper drainage was secured. The prostate should be approached from the perineum by incision in the median line, going down layer by layer between the bulb and the rectum until the gland is reached. A bougie should be introduced into the urethra in order that it may be avoided. Some operators prefer a transverse or an elliptical incision in front of the anus.

Wickham and Desnos both advocate a trial of the sclerogenic method of Lannelongue, which consists in the injection of a solution of chloride of zinc around the area involved, after having made a perineal section.

Tumors.—Cysts are occasionally found in the neighborhood of the prostate. These may be either hydrops of the seminal vesicles, dermoids, or echinococcus cysts. More rarely they may result from dilatation of the sinus pocularis. Thompson refers to 7 cases of hydatid cysts between the bladder and the rectum near the neck of the former, which caused retention of urine. In 3 instances the condition very closely simulated that of prostatic enlargement, and in 2 the prostatic catheter was employed under the belief that this was the source of the trouble.

The **diagnosis** of these cysts, which usually cause retention of urine when they attain a sufficient size to disturb the relations of the urethra and bladder, would be made by excluding other causes of retention, other forms of tumor, by passing the catheter or sound, by rectal touch, etc. Usually it is possible to detect a fluctuating swelling in the rectum which has been mistaken for the distended bladder. Thompson reports the case of a boy nine years old who was supposed to have retention of urine. A trocar was introduced through the rectum for the purpose of relieving the supposed distended bladder, as no instrument could be passed by the urethra. The cannula withdrew not urine, but fluid from a cyst. The patient was cured. In a somewhat similar case Bryant made a rectal puncture without effect. He then made a perineal incision and evacuated an echinococcus cyst the contents of which measured three quarts.

Treatment.—As already indicated, this consists in withdrawing the fluid by means of a trocar and cannula or an aspirator through the rectum or by incision in the middle line of the perineum.

Carcinoma.—Carcinoma of the prostate is a rare affection. According to the statistics of Tanchou, it was recognized as a primary lesion 5 times in 1904 males who died of carcinoma. Of the entire collection of 8289 cases, the bladder was given as the seat of the disease 72 times, of which one-half or more could very properly be said to have occurred in males. Many of these doubtless started in the prostate, involving the bladder secondarily, so that the 5 cases mentioned considerably understate the true proportion. The form of carcinoma met with in the prostate is the encephaloid. Thompson thinks the evidence of the occurrence of true scirrhus is wanting. He further states that no authentic case of malignant disease is on record between the ages of eight and forty-one.

In 28 cases of carcinoma of the prostate collected by Wyss there was carcinoma also of other organs—the kidney, testicle, greater and lesser omentum, vertebra, liver, lung, and pleura.

Two forms of the disease are described: (*a*) A circumscribed variety, growing slowly and remaining nearly or entirely limited to the prostate; (*b*) a diffuse, rapidly-growing variety, called by Guyon the "diffuse prostato-pelvic" form.

Symptoms.—The symptoms of carcinoma of the prostate are those of prostatic obstruction from other causes, but they generally develop with greater rapidity. There is, however, as a rule, more acute pain in the perineum and rectum, in the course of the crural and ischiatic nerves, in the nates, the lumbar region and glans penis, more or less frequent hemorrhages, and sooner or later cachexia. The blood is frequently voided almost pure and either during or after attempts at micturition. In some cases the hemorrhage is almost continuous, communicating a bloody tinge to the urine, which is more pronounced at some times than at others.

The enlargement of the prostate when due to carcinoma is always hard at first, although some softening may take place at a later period. The outline of the gland may be regular or nodulated. The adjacent lymphatic glands sometimes become involved, and enlargement of those accompanying the iliac vessels or of those in the inguinal region, if observed, would be very significant. According to Wyss the inguinal, mesenteric, and retroperitoneal glands are relatively infrequently affected. In the 28 cases reported by him the inguinal glands were enlarged but 3 times.

The urine should be examined for the presence of fragments of tumor which may be found from time to time in cases of fungating growths. Pus is also frequently present in the urine.

Diagnosis.—Careful attention to the history and symptoms, together with the usual urethral and rectal examinations, will commonly lead to a correct diagnosis. The features which are most characteristic are the hardness of the prostate as felt by rectal touch, the severity of the pain and its wide distribution, and the rapid course.

As a rule, the troubles in connection with prostatitic hypertrophy are especially marked at the acts of micturition, while the symptoms of carcinomatous involvement are independent of urination.

If infiltration of the wall of the rectum or of the seminal vesicles is detected, the disease is probably carcinoma if tuberculosis can be excluded. If the person is not too corpulent and the bladder empty, valuable information may be obtained, by bimanual palpation under ether anesthesia.

The cystoscope may aid in clearing up a doubtful diagnosis in rare instances. It will be useless in the cases in which there is free hemorrhage, either spontaneous or induced by the introduction of an instrument.

Hematuria occurs in both hypertrophy and carcinoma, but is apt to occur earlier and to be more profuse in the latter.

If fragments of growth be found in the urine, they may be a valuable aid in arriving at a diagnosis. It is, however, generally admitted at the present time that individual cells in the urine are in no wise characteristic. The different portions of the urinary passages furnish epithelial cells of all forms and sizes, which would make the detection of "cancer-cells" extremely doubtful.

It is doubtless true that a certain percentage of cases of enlargement of the prostate considered to be of senile origin have in reality been cases of malignant disease. The possibility of a prostate already the seat of hypertrophy becoming affected with carcinoma must also be borne in mind. Thompson has recorded an example of this condition, and Isnardi has reported an instance in which he performed ligation and division of the vasa deferentia for prostatic hypertrophy in a case which was later found at post-mortem examination to have been one of cancer of the prostate.

Treatment.—The treatment of carcinoma of the prostate will consist, in many instances, solely in meeting indications as they arise. It is desirable to avoid the use of urethral instruments if possible, but if there is retention it will be necessary to use a catheter, preferably one of the soft varieties, at regular intervals. If the pain is excessive, it should be allayed with opium or morphine. If the hemorrhage is profuse, the patient may be given the fluid extract of ergot, gallic acid, aromatic sulphuric acid, or some other astringent internally. At the same time, it is desirable to secure rest in bed, with the hips elevated on a thick pillow. Cold applications may be made to the hypogastrium and perineum, and cold rectal douches may be given or small suppositories of ice may be employed.

In rare cases it may be proper to attempt to remove the diseased gland. Küchler of Darmstadt advocates the removal of the prostate by median perineal incision or by going through the anterior wall of the rectum. After reaching the gland it is to be drawn downward with forceps, split in the middle line, and each half removed separately. It is necessary to introduce an instrument into the urethra in order that it may be recognized and avoided. Küchler has operated on the cadaver only, but is so convinced of the practicability of the operation that he says he shall employ it in the first suitable case that comes under his care. Billroth appears to have been the first to remove a malignant tumor of the prostate in the living. The patient did well after the operation. A recurrence could be detected two months later, however, and the patient died fourteen months after the operation. The whole course of the case was six years. The method of operation is not stated. Another case operated on by Billroth and recorded by Winiwarter, in which a median cystotomy was performed, lived but four days after the operation. Demarquay reports a case in which he removed the lower portion of the rectum, the prostate, the seminal vesicles, the fundus of the bladder, and nearly the whole of the membranous urethra for an extensive carcinoma of the prostate. The patient died at the end of seven days from peritonitis. Harrison reports a case operated upon by the median perineal incision that remained well for fourteen months after the operation, when the glands of the groin began to enlarge, and the patient died at the end of two months. Leisrink operated in one case by making a semilunar incision from one tuberosity of the ischium to the other, anterior to the rectum. The prostate was easily brought into the wound by means of a strong hook and separated from the bladder and other contiguous structures. In this case the anterior wall of the bladder was sewn to the upper extremity of the membranous urethra, and the posterior wall was brought downward as far as possible, in order to close the gap as nearly as might be. Stein reports from the Heidelberg clinic a case in which a boutonnière was made on account of retention, and as the bladder did not drain well a suprapubic cystotomy was performed, but without affording relief. He reports another case in which, after a suprapubic cystotomy, a soft, compressible tumor was removed from the left lobe of the prostate, partly by the finger-nail and partly by the sharp spoon, and the wound cauterized with the Paquelin cautery. The bladder-wound was left open and a permanent catheter introduced into the urethra. The patient was discharged at the end of four weeks, free from pain and able to retain his urine from four to five hours. The urine was clear, acid, and free from tumor particles. Two other cases are reported; one lived nine months and finally died of uremia, and the other succumbed on the twelfth day after operation from double pleuro-pneumonia.

Sarcoma.—Sarcoma of the prostate may occur at any age, but is most frequent in early life, and at least one-half of all the cases are said by Barth to appear between the first and eighth years. This observation may be explained by the fact that at this period the muscular and connective tissues are greatly in excess of the glandular elements. Sarcoma appears to be the only form of malignant tumor which affects the prostate in childhood.

Symptoms.—The common symptoms are dysuria, retention, perineal pain, constipation, and the presence of a tumor detected by rectal palpation. Hematuria is usually present, and pus in the urine is commonly observed. The growths in some cases reach considerable proportions, when difficult and painful micturition and defecation are complained of. The sensation given to the examining finger in cases of sarcoma of the prostate is that of a semi-fluctuating tumor. Many forms of sarcoma have been described in connection with the prostate.

Diagnosis.—In the great majority of cases sarcoma makes its appearance in early life, before either hypertrophy or cancer of the prostate would be observed. The disease usually runs a more rapid course than any other form of growth involving this region. The duration varies from six weeks to two years, the fatal termination frequently occurring in from six to seven months. The condition of the patient may not be seriously affected so long as the functions of the bladder and bowels are not interfered with. Death may occur from an ascending pyelonephritis or metastasis if the patient does not succumb to the local extension. The tumor in some cases becomes so large as to be seen and palpated above the pubes.

Tuberculosis of the prostate is the only condition with which sarcoma would be apt to be confounded. In some instances the growths are limited to one lobe.

Treatment.—As in the case of carcinoma, the treatment will in many cases be palliative only. The disease is apt to be so diffused by the time the patient consults a surgeon that operation is not to be thought of, except if necessary to relieve painful symptoms. If there is retention, either a perineal or a suprapubic opening will be necessary to drain the bladder. If the diagnosis was made early, an attempt might be made at radical cure. Czerny operated upon a case by the suprapubic route and scraped out a sarcoma of the prostate, which is said to have been followed by improvement in the urinary symptoms, but the duration of the improvement is not stated. If there is obstruction of the bowel, it may be necessary to perform colotomy. It is needless to say that in the vast majority of cases the prognosis is absolutely hopeless.

Prostatic Calculi.—Prostatic calculi are of two kinds—those formed in the kidney or bladder and lodging in the prostatic sinus, and those which originate in the gland itself. They vary in size from that of a pin's head to that of a nut. They may be either single or multiple, and may occupy a pouch connected with the urethra or they may be imbedded more deeply in the substance of the prostate. In composition they are mainly phosphate of lime.

The **symptoms** induced by the presence of these calculi are those of prostatic or vesical irritation. In some cases the size and form are such as to interfere with the free passage of urine, and difficult micturition or even retention results in consequence.

The **diagnosis** is easy in the cases in which a grating sensation is imparted to the hand on passing a urethral instrument. The presence of a calculus of large size may often be detected by noting a hard, irregular body in the substance of the gland by rectal touch. Sometimes these concretions are followed by the formation of an abscess of the prostate, when the symptoms of the latter would be most prominent.

The prophylactic **treatment** is identical with that applicable to the prevention of calculi in any portion of the urinary tract—namely, the correction of undue acidity of the urine by the administration of one of the salts of lithium or similar remedies, or of alkalinity by boric or benzoic acid, and overcoming too great concentration by the free use of lithia or other diuretic water.

Small calculi lying in the prostatic urethra may sometimes be extracted by means of appropriate forceps. If this is impossible, it will be necessary to perform a median perineal urethrotomy in order to remove the stone. If an abscess should form, immediate operation is to be recommended.

Polyps of the Prostatic Urethra.—These are of very rare occurrence, but the possibility of their existence must not be lost sight of.

The common symptoms are hemorrhage from the urethra, perhaps some obstruction to the passage of urine, and difficulty in catheterization. There may be also some vesical irritation and increased frequency of micturition. Mr. Bryant[1] reported the case of a man sixty-three years of age who had complained of hematuria for six years. The hemorrhage at times was very profuse. A median perineal cystotomy was performed, partly for diagnostic purposes, when the bladder was found free from disease and the vesical lobe of the prostate was not enlarged, although the lateral masses were greatly hypertrophied. On careful exploration of the prostatic urethra with the finger a small polypus was detected projecting from the floor. The pedicle was divided with scissors. A year and a half later the patient was in good health, the prostate having contracted to the normal size. A distinctive feature of these growths in the urethral canal is hemorrhage independent of urination. In this case suprapubic operation would entirely have failed to locate the source of the trouble. On microscopic examination the growth was found to be purely prostatic.

Atrophy of the Prostate.—Atrophy of the prostate is a rare condition observed in some instances in wasting diseases. It is also met with in very advanced age. It is probable that it would commonly be found after the period at which the testicles become functionless. It has been shown by a number of observers that active spermatozoa continue to be formed late in life, so that the individual is usually carried off before atrophy of the testes takes place. Absence of one or both testicles or atrophy from any cause will usually be followed by a shrinkage of the prostate. Atrophy of the prostate may also be expected in any case in which the development or integrity of the testicles has been interfered with.

The condition does not give rise to any **symptoms** unless it be sterility.

No **treatment** is called for, and there is none that would be of any avail.

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[1] *Lancet*, London, 1893, vol. i.

DISEASES OF THE BLADDER.

BY EDWARD MARTIN, M. D., AND A. E. TAYLOR, M. D.

ANOMALIES OF THE BLADDER.

THE bladder is formed from the lower portion of the stalk of the allantois. It is toward the close of the second month that the stalk becomes dilated. It is in communication behind with the uro-genital cloaca, and is separated from the rectum by a septum which becomes complete during the third month. The ureters originally opened also into the uro-genital cloaca, and when the closure occurs it is behind and below them. The primitive bladder is at first spindle-shaped; one end, being the prolongation of the stalk of the allantois, extends up to the umbilicus (the remains of the early tube which communicated with the allantois), while the other end communicates by a short tube with the primitive intestine. The upper end, the remains of the upper part of the allantoic stalk, becomes obliterated and constitutes the urachus. The canal which communicates with the primitive intestine becomes the first part of the urethra. It is in connection with closure of the anterior wall, the urachus, and the posterior connections of the primitive bladder that the malformations of this organ occur.

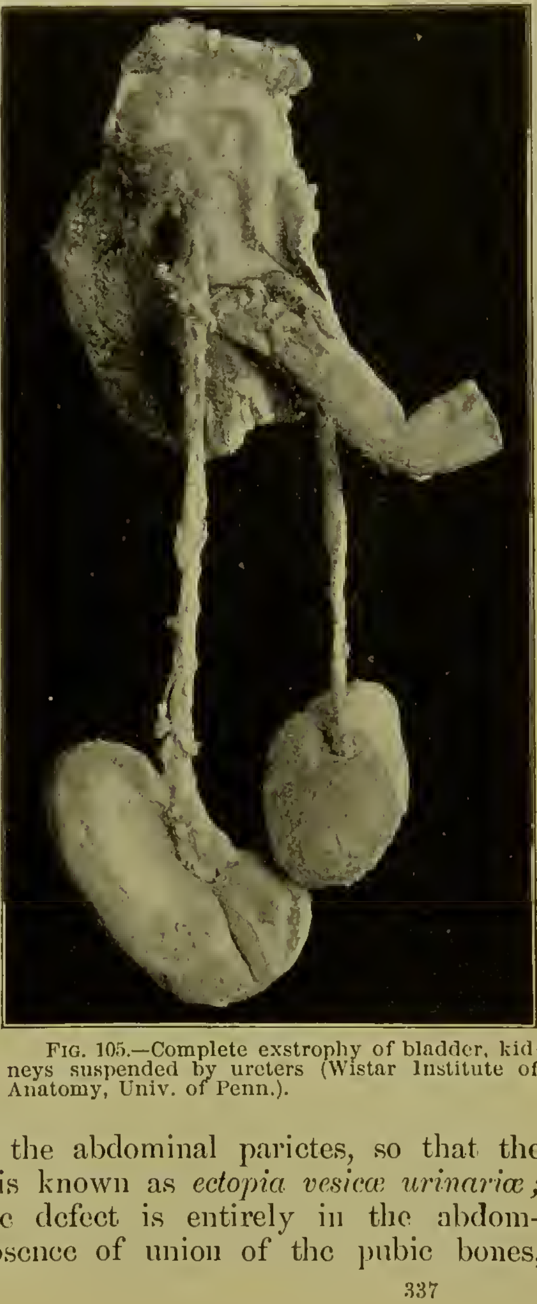


FIG. 105.—Complete exstrophy of bladder, kidneys suspended by ureters (Wistar Institute of Anatomy, Univ. of Penn.).

Exstrophy of the bladder is the most important malformation. The general condition, exstrophy, implies a cleft in the anterior abdominal and vesical walls. There are, however, many degrees of this malformation. There may, in the first place, be a simple lack of union of the abdominal parietes, so that the bladder projects into the cleft. This is known as *ectopia vesicæ urinariæ;* the bladder is normally formed, the defect is entirely in the abdominal wall. Another form is the absence of union of the pubic bones, together with the cleft in the parietes just described. When the division affects not only the parietes, but also the anterior wall of the bladder, the condition of true exstrophy exists. When the cleft in the bladder is at the top of the anterior wall and the symphysis is closed, the condition is termed *fissura vesicæ superior*. When the cleft is in the lower anterior wall of the bladder, the symphysis pubis being normally united, the condition is named *fissura vesicæ inferior*. The third degree, *eversio vesicæ* (Winckel), designates the condition in which there is a cleft in the parietes and the anterior bladder-wall, together with lack of union of the symphysis pubis. Above the bladder there is often an area in the median line composed of connective tissue, but not covered in by skin.

With this malformation others are commonly associated: epispadia of the penis or clitoris is very often seen, and usually there is a marked aplasia of these organs; in the female particularly the urethra becomes reduced to a short, shallow groove. The scrotum may be entirely normal, also the testicles, but the latter are frequently very imperfectly developed or undescended. Cleft scrotum has, however, been rarely observed. External inguinal herniæ are quite commonly observed, unilateral or bilateral: it is probable that these are simply the result of the weakness of the abdominal walls. Ventral herniæ are also commonly observed just above the bladder: this is the result of a lack of union of the recti abdominales muscles at the linea alba above the point where the skin closes in the cleft; should this skin be cleft, the condition would be that of fissura abdominalis. Anomalies of the kidney, ureters, absence of the prostate or seminal vesicles, double uterus or vagina, patulous urachus, are conditions which may accompany exstrophy.

In a few cases the posterior closure is not complete, so that the intestine opens into the bladder, while the colon is rudimentary. In other cases the rectum communicates with the bladder.

In any case of exstrophy the posterior wall of the bladder is exposed, and if the defect be sufficiently large, the openings of the ureters are visible. Usually there is almost no urinary cavity, but in the recumbent position there may be exceptionally a cavity of considerable capacity. In the fissuræ superior or inferior there is obviously more or less of a bladder-cavity.

In marked cases of exstrophy the exposed mucous membrane extends from the genitalia up to the umbilicus: this is always in a condition of chronic or subacute inflammation, while at the sides and above where it joins the skin a zone of granulations is usually present. The skin upon the parts of the body upon which the urine dribbles is inflamed and excoriated, and may be the seat of a severe dermatitis. The degree of secondary inflammation corresponds inversely to the care given the patient.

In the cases in which the intestine or rectum opens into the bladder the bowel-contents greatly aggravate the severity of the inflammation and markedly favor ascending infection.

Exstrophy is usually observed in the male, very rarely in the female.

Symptoms.—These consist in the appearance of the deformity, together with the secondary inflammation. The conditions of cleft in the abdominal wall, with or without cleft symphysis, give no urinary symptoms, and are important on account of intra-abdominal rather than urinary complications.

Prognosis.—When the ureteral openings remain unobstructed, in spite of the severe cystitis which invariably accompanies exstrophy, there is little tendency toward ascending infection of the kidneys. In the majority of cases, however, from infiltration and thickening of the mucous membrane, often aided by papillary outgrowth, there is a tendency toward gradual ureteral obstruction, with dilatation of the ureters and ultimate degeneration of the kidney-substance. Even under these circumstances ascending infection is not so common as would naturally be expected. It is most likely to take place shortly following operation for the closure of the bladder, and is then probably due to retention of urine, with back pressure into the ureters, already chronically congested and ripe for infection.

Probably the large majority of cases of exstrophy perish in infancy or early childhood, and usually as a result of surgical operations, since the condition is so distressing that no risk seems too great to be taken, provided there is a prospect of ultimate cure. With the improved technique and the more rational conception of urinary antisepsis it is reasonable to hope that the prognosis of this affection and of the operations performed for its relief will be materially improved in the future.

Treatment.—The slighter degrees of exstrophy may be satisfactorily treated by a urinal. Where the defect is large, even the most carefully adjusted appliance either fails to prevent leakage of urine or produces pressure-ulceration. Because of the constant dribbling of urine and the painful inflammation of the vesical mucosa and surrounding skin these patients nearly always consent to surgical operation.

Before operating for exstrophy the skin and mucous membrane of the bladder must be brought into as healthy a condition as possible. This is effected by rendering the urine bland and unirritating by administering urinary antiseptics, such as salol and boric acid; by irrigating twice daily the skin and vesical mucosa with nitrate of silver, 1 : 2000, or witch-hazel, 1 : 5, or other antiseptic astringent lotion; by protecting the surrounding skin by a thick, pasty ointment of zinc oxide. It is well to delay operation until the third or fourth year of life, though from earliest infancy an attempt should be made to close the bony defect by a spring truss or an elastic bandage.

The defect in the bladder-walls may be closed by flaps raised from the surrounding integument or by dissecting the bladder free from its parietal attachments and folding it in upon itself. The area to be covered by flaps may be materially lessened and the bladder-cavity may be increased by bringing the pubic bones together; finally, in place of attempting to form a new bladder, the urine may be diverted from its normal course and may be made to flow either from some portion of the surface or into the bowel.

Closure by Skin-flaps.—Of the flap operations, the two which have stood the test of clinical experience are Wood's and Thiersch's.

In *Wood's operation* the abdominal defect is covered in by three flaps: the first is formed above the defect, and is of such size that when turned downward it completely covers the exstrophied bladder without tension. The skin faces toward the vesical mucous membrane, and is designed to form the inner surface of a new anterior vesical wall. Preceding the operation all the hair-follicles upon this surface should be destroyed; otherwise the growing hair will form nuclei for phosphatic deposits. Two lateral flaps are cut from either inguinal region and turned inward, the raw surfaces being apposed to the raw surface of the upper flap, which has been turned down.

Wood's directions for cutting these flaps are as follows: The length of the upper flap should be equal to the distance from the root of the penis to the upper margin of the bladder. This is outlined by carrying a cut vertically upward from the side of the bladder the required distance convexly across the front of the belly and vertically downward to the other side of the bladder. The inguinal flaps have a rounded shape, with their attached pedicles lying in the base of the scrotum, the incision being carried downward on the side of the urethral groove half its length. The length of these lateral flaps should be so calculated that when freed and carried to the middle line of the body their entire inner surfaces can be apposed without undue tension. The cut by which they are outlined joins the vertical incision made for the formation of the upper flap about its middle.

In dissecting the upper flap it must be remembered that the tough tissue filling in the interval between the separated recti muscles is extremely thin and that the peritoneal cavity may be readily entered.

The flaps having been freed, care being taken to avoid bruising or devitalizing them in any way, and the bleeding having been checked, the upper one is folded downward and secured by catgut sutures to the borders of the incision at the root of the penis. The inguinal flaps are then brought inward, their raw surfaces being apposed to the raw surface of the upper flap, and are sutured in the middle line, the lower portions being brought together over the root of the penis as closely as possible. The raw surfaces left after securing the flaps in place are closed by plate sutures or hare-lip pins.

Thiersch's operation covers in the bladder by lateral flaps. These are made larger than is apparently necessary, to allow for shrinkage, and are not shifted into position for several weeks after they have been raised from their deep connections, pieces of tin-foil being placed beneath them until the surfaces have granulated.

The first flap is formed by two vertical incisions, and is of a size sufficient to cover the entire exstrophied bladder. The first incision passes from the upper border of the defect to the root of the penis immediately beside the bladder; the next is parallel to this and is continued down to Poupart's ligament. This flap is undermined throughout its whole extent, and separated from the underlying superficial fascia by tin-foil. In three weeks the upper extremity is cut free, and the flap is carried across the lower portion of the defect, and is secured in place by suturing it to the freshened margin. After healing has taken place the second flap is cut on the other side of the bladder, the lines of incision being the same, with the exception that they are not carried below the upper attachment of the first flap, but, beginning at this point, are continued upward above the upper borders of the defect. This flap is treated as the first one was. In three weeks it is freed above, is carried across the bladder, and secured to the freshened surface on the outer side, thus closing the upper portion of the defect. After complete healing the adjoining borders of the two flaps are freshened and secured by suture. The final step of the operation consists in freshening the upper border of the upper flap and securing it to the freshened abdominal walls above.

Before the anterior wall of the bladder is completely formed by the flap method repeated operations are necessary. As many as eighteen or twenty have been required even by surgeons most expert in this class of work, and the course of treatment has been continued over one or two years.

Closure by Direct Suture.—The formation of the vesical cavity by direct union of the freshened edges of the defect is always the operation of choice when it is practicable. It can usually be made practicable by performing a preliminary disjunction of the sacro-iliac symphyses, but this preliminary operation is not devoid of risk, and in the main the results have been bad. By lateral pressure in young children the pubic bones can be brought together without preliminary operation. The edges of the abdominal defect are freshened and approximated by suture.

When it is impossible to close the bladder in the aforesaid manner, Segond has proposed an operation which more fully realizes the requirements of ideal plastic surgery than the methods already described, since it makes a new vesical cavity, the walls of which are made up entirely of mucous membrane. The method consists in performing an extraperitoneal dissection of the mucous membrane of the bladder, turning this flap down, and securing it to the freshened borders of the penile furrow. An incision is then made through the prepuce; it is drawn over the glans, dissected up, and its raw surface, together with lateral abdominal flaps, is used to cover in the mucous membrane thus obtained.

The main objection to this operation is dependent upon the fact that it is difficult to dissect up the mucous membrane without either injuring the peritoneal cavity or making the tissue so thin that its vitality will not be preserved. The dissection should be carried downward and backward to a point a little above the attachment of the ureters, the entire flap being utilized.

Pousson has proposed a modification of this operation which practically does away with its one objectionable feature. He carries an incision along the border of the exstrophied bladder into the peritoneal cavity, thus forming a flap made up of the entire thickness of the bladder-wall. This is turned down, sutured to the freshened penile furrow, and the resulting defect in the abdominal wall is closed by direct suture.

Derivation of the Urine.—The method of derivation, which at one time was practically abandoned because experiments and clinical trials seemed to show that it was invariably followed by ascending infection, has received a new impetus by more modern investigations, which apparently prove that ascending infection is not inherently connected with implantation of the ureter into the bowel, but is due rather to cicatricial contraction, and consequently narrowing of the new ureteral orifice, from which result hydronephrosis, congestion, and infection. When the vesical orifice of the ureter is transplanted into the bowel such infection apparently does not take place.

The operation of choice is that described by Maydl. The peritoneal cavity is opened along the borders of the abdominal defect, the urethral continuation of the bladder is cut across, ureteral catheters are inserted, and the entire bladder is resected, with the exception of a small oval portion circumscribing the ureteral orifices. This flap, with the ureteral orifice, is made freely mobile. The colon is then drawn forward, a longitudinal opening is made into it, and the vesical flap attached to the two ureters is sutured in this opening. The first line of sutures unites the mucous membranes; the second line apposes the serous and muscular coat of the gut and the muscular coat of the bladder-flap. The operation is concluded by closing the abdominal opening.

Pousson has lately tabulated 52 operations for exstrophy of the bladder performed since 1889: 4 cases perished; these all followed Trendelenburg's operation of direct suturing of the freshened borders of the bladder after closure of the bony defect by symphysiotomy. One of the fatal cases was due to chloroform, 1 to iodoform intoxication, 2 to acute nephritis.

In Segond's tables no deaths are found among the cases treated by the autoplastic method or by derivation of the urine. The author holds, therefore, that the dangers of these operations are reduced to a minimum, and that the surgeon should select his method uninfluenced by fear of mortality, but rather with a view to the best results—*i. e.* protection of the mucous surface, collection of the urine, and return of the external genital organs to a normal appearance.

Segond holds that the ultimate results of the autoplastic method are excellent. Of 17 operations, there was only 1 failure from sloughing of the flap. In the remaining cases the restoration of the anterior surface of the bladder and the upper wall of the urethra was perfect, with the exception of 1 case, in which a fistula remained.

As to the functional results, these are no better than in former years. It is possible in some cases for the bladder to retain urine for five or six hours, not because of preservation of muscular fibers, but because in the formation of flaps the urethra was so well closed that it only yielded to considerable tension from within.

The skin-flap operation is nearly always followed by the formation of calculi. These, however, do not cause a great deal of trouble, and unless the urethra is tightly closed can be readily removed.

Methods of direct suture of the margins of the bladder have been practised in 127 cases; in 16 of these the pubic bones were brought together either by means of pressure-apparatus or by operation. The defect was readily closed, but the bladder was no more retentive than in other ways.

Segond's method of dissecting loose the mucous membrane of the bladder and turning it down has been performed 10 times with excellent results; the flap retained its vitality.

The method of derivation performed twice by implanting the ureters into the furrow and covering this with transplanted prepuce, gave satisfactory results. The implantation of the ureters into the rectum or colon was not followed by inflammation of the bowel or rectum, as at one time feared. Krinsky reports a patient with rectal implantation who can retain urine for three or four hours without inconvenience.

The statistics of Pousson, which have just been summarized, are, we believe, utterly misleading. He would have us believe that, in so far as the mortality of the operation is concerned, excepting for disjunction of the sacro-iliac symphysis, the operation of exstrophy is an absolutely safe one. On the contrary, it is extremely dangerous. The great majority of fatal cases do not appear in medical literature. It can be confidently asserted that practically all the successful cases are published; unfortunately, they are often published so shortly after operation that they are utterly useless in so far as considering the immediate and remote mortality of the various operations is concerned.

The authors believe that the high mortality, which we should place at between 30 and 40 per cent., even from the autoplastic method, is due to ascending nephritis, and this in turn is excited because the surgeon attempts too much. He endeavors to close the bladder so that it may act as a reservoir—hence adds to the chronic cystitis, rendered acute by the mechanical disturbance incident to operation, the element of more or less retention. The writer knows of 8 cases of exstrophy in which operation was performed by different surgeons, with a mortality of 50 per cent. None of the fatal cases have appeared in medical literature.

The writer believes that immediately following flap operations the bladder should be frequently irrigated and freely drained—that no effort should be made to form a reservoir, the surgeon directing his attention mainly to covering the defect and enabling the patient to wear a serviceable urinal.

The plastic method which promises most is that in which the whole bladder-wall is freed from its parietal attachments and turned down, since thus the danger of calculus-formation is obviated.

The implantation method must still be considered as on trial. Should it be definitely proven by a wider clinical experience that ascending infection does not result from rectal implantation of the ureters, together with a surrounding portion of the bladder-wall, this will undoubtedly be the method of choice.

The mechanical treatment should begin immediately after birth, an elastic bandage or truss being so fitted to the child that constant pressure is exerted, having for its end the approximation of the pubes. Operation for closure of the defect should be undertaken about the third or fourth year.

Recto-vesical fistulæ are rare forms of congenital malformation, and are due to a failure in the closure of the septum which divides the primitive dilatation of the stalk of the allantois into the rectal and vesical cavities. The entire dividing wall may be absent or only a small fistulous tract may exist.

Symptoms.—The symptoms of this condition are those of recto-vesical fistula in general, and will depend for their severity on the size of the opening. The most obvious symptoms are the passing of gas and portions of feces per urethram, cystitis, and watery diarrhea. Cystitis is always present and is severe. Ascending infection occurs early.

Treatment.—Cases of congenital and posterior defect of the bladder, rare even in museums, are so seldom encountered in clinical practice that the treatment for the condition has not been formulated. On general principles it may be said that the small opening should be dealt with as an acquired recto-vesical fistula. A large opening might be treated by suprapubic cystotomy and closure.

Patulous urachus is a not infrequent malformation. This may be complete or incomplete. When complete, urine escapes at the umbilicus. When incomplete, the condition may be present in one of three forms: (1) patent at the vesical end and closed at the umbilicus; (2) patent in the center, but closed at both ends; (3) closed at the bladder, but patent through the rest of its course, and open at the umbilicus. In the complete form the urachus may be so large as to allow of a partial or even complete prolapse of the vesical wall.

Patent urachus has in some instances been caused by obstructions to the natural flow of urine, but this is not the rule. Calculi have been found in the tract, and suppuration is almost constant.

Symptoms.—An escape of urine or muco-pus from the umbilicus, or the formation of an elongated cystic tumor occupying the position of the urachus, sufficiently indicates the nature of the affection.

Treatment.—Since the escape of urine from the umbilicus is often due to a condition of vesical tension caused by urethral obstruction, the first consideration in the treatment of patulous urachus is the provision for the unobstructed escape of urine by its natural channel. When this end has been accomplished, either by incision of a narrowed meatus, for instance, or removal of a valvular obstruction, and when the escape of urine continues, the umbilical opening may be touched by the galvano-cautery. Powdered acetanilid is dusted over the seat of cauterization, and a compress of antiseptic gauze is secured over the umbilicus by means of adhesive straps.

If this method of treatment is unsuccessful, the umbilical opening, together with the accessible portion of the urachus, may be freshened and apposed by suture. This failing, the urachus may be freed by an incision made in the linea alba, carried from the umbilicus to the pubis, and the urachus may be divided a little above the bladder, invaginated upon itself, and sutured: the upper portion of the canal should then be removed, since it represents a suppurating mucous channel. This operation would be especially indicated when calculi are deposited in the urachus or when this canal, patulous in its middle portion only, forms a retention-cyst.

Multiple bladder is a condition infrequently referred to, but true multiple bladder is very rare. Vesica bipartita is produced by a central antero-posterior membrane dividing the organ into two halves, each with its own ureter: the dividing membrane may be complete or incomplete, and the division may extend down the urethra. It is doubtful whether a horizontal division of the bladder has ever existed. All other conditions known as multiple bladders are doubtless diverticular formations or congenital cysts.

Congenital diverticula usually occur just to one side and in front of the mouth of the ureter or above it, and are probably due to the arrangement of the muscular fibers (Englisch).

The cystic conditions which are liable to be mistaken for multiple bladder are—cysts of the urachus, of a blind ureter, of the seminal vesicles, or of the utriculus prostaticus.

Complete absence of the bladder has been described by Merckel, Blasius, Fleury, and Oliver. The ureters ended in the urethra; there were no other malformations.

There have been, furthermore, cases of widespread uro-genital malformation in which the bladder has seemed to have been absent and the ureters emptied into the rectum or vagina.

Congenital hypoplasia has been rarely observed; the bladder in such a condition is so small that urine must be voided very frequently. Another rare condition is atresia of the neck of the bladder, causing death from distention and back pressure.

Treatment of *multiple bladder* or congenital diverticula would not be required, excepting after the advent of cystitis. This complication having once developed, it is likely to persist, since in these deformed bladders there is a tendency toward stagnation of urine, which necessarily aggravates the inflammation. The best that operative interference can promise in such cases is the removal of partitions which interfere with free drainage. Such an operation is not likely to be planned beforehand, but if in the course of suprapubic cystotomy for stone, for instance, or for severe cystitis, diverticula or partitioned bladder should be found, such procedure might be serviceable.

The only treatment which is applicable to the complete *absence of the bladder* is either the wearing of a properly fitting urinal or implantation of the ureters into the bowel.

Congenital hypoplasia, a condition in which the patient has to urinate very frequently because of smallness of the bladder, has been successfully treated by long-continued progressive dilatation by means of hydrostatic pressure.

The diagnosis of this condition is extremely difficult, and should not be formulated until the patient has been examined under profound narcosis. If the history of the case shows that there has always been frequent micturition since earliest childhood, that the frequency is both nocturnal and diurnal, that there is no cystitis or no cause for vesical irritability, and if examination under ether by palpation and injection of measured quantities of fluid shows an abnormally small bladder, it is fair to assume that the cause of frequency may be due to incomplete development.

Under these circumstances the bladder may be distended by means of a gravity-bag and a short urethral nozzle once daily or once every other day, the quantity of fluid injected being slowly increased. The treatment may have to be continued for from six months to a year. Successful results have, however, been recorded. It seems scarcely necessary to call attention to the fact that when the bladder is emptied with undue frequency the kidneys are always in a more or less congested state, and that the infection in these cases is likely to result seriously.

Atresia at the bladder-neck should be treated by cutting or dilatation.

CYSTITIS.

Under the heading of Cystitis we shall describe all forms of inflammation of the bladder. The cystites are manifold in their origin, lesions, and course. We do not believe that all cystites are caused by pyogenic micro-organisms. Not only are there aseptic inflammations of the bladder in which there is no form of pus produced, but there are purulent inflammations in which necrobiosis has been the primary condition and the suppuration secondary. The distinctions are often of practical importance, and will be brought out in the discussion of the etiology and pathology.

Etiology.—The causes of cystitis are extremely numerous. They can, however, be conveniently grouped into classes:

1. **Cystites occurring during the Course of Acute Infectious Disease.**—Acute articular rheumatism, typhoid fever, diphtheria, scarlet fever, small-pox, measles, influenza, mumps, cholera, cerebro-spinal fever, and typhus are the diseases of this class in which cystites occur—most frequently in typhoid fever, scarlet fever, and diphtheria. This complication may set in during the height of the disease or may appear during convalescence. Toward its cause a number of factors probably contribute. The chemical constituents of the urine are often profoundly altered: the urine is concentrated; it contains abnormal substances which have come from the disturbed metabolism of fever and specific infections. Furthermore, the tissues of the bladder are doubtless improperly nourished, and are thus deprived of their full powers of resistance.

Whether or not the cystitis be a local manifestation of the micro-organisms which we know or suppose to lie at the bottom of the diseases is almost entirely a matter of conjecture. For typhoid fever, diphtheria, and cholera, whose micro-organisms are at least partially well known, the cystitis has not, as a rule, been shown to be the result of a local action of their bacteria. The forms of cystitis seen in these diseases are simple inflammation, purulent inflammation, membranous and phlegmonous inflammations.

2. **Cystites occurring during the course of constitutional diseases,** such as gout and diabetes. In both these diseases the conditions are hard to explain. From what we now know of gout, it cannot be held that uric acid produces it, and, since the urine in these cases is not always concentrated, the oft-given explanation of direct irritation falls to the ground. In cases of gout associated with gravel the cystitis is of obvious origin.

In diabetes some cases develop with an acid urine, and here the causation is entirely obscure; in other cases there is fermentation of the glycogenic urine within the bladder, following which the urine becomes ammoniacal, and here the inflammation has probably been the result of the chemical irritation.

3. **Cystites complicating Nervous Diseases.**—Cystites of neuropathic origin may be caused by paralysis of the bladder or by trophic changes in the bladder-tissues. These may coexist, but they need not. In any form of paraplegia or myelitis vesical paralysis and retention may occur, and under such favorable conditions infection soon follows. In the slow scleroses and in the general paresis of the insane there is often a marked atrophy, particu-

larly of the tunica muscularis, which may result in a hernia of the mucous membrane and rupture.

Trophic changes are frequent and often extensive, appearing in forms of necrosis and membranous formations, widespread phlegmonous infiltrations with paracystitis, and not infrequently rupture: these are the striking phenomena observed in the cystites of nervous diseases.

4. **Cystites developing in the Course of General Septic Conditions.**—Erysipelas, pyemia, internal suppuration in almost any part of the body, may produce a metastatic suppurative cystitis. It must be borne in mind that the pyemia need not be a manifest clinical condition: it may be the so-called cryptogenic pyemia, of which the metastatic cystitis (or other local suppuration) is the first clinical sign. These cases are very common in connection with paravesical sepsis. The extension may be by contiguity or by the lymph- or blood-channels.

Such infections occur in connection with suppuration in the uterus or adnexa, in the scrotum or its contained tissues, in the pelvic, lymphatic, and connective tissues; from adjacent bone-suppurations; from the appendix, caput coli, cecum, rectum, intestines, ischio-rectal space, paranephritic tissue; from peritonitis, however produced. The infection is sometimes due to a recto-vesical or vesico-vaginal fistula.

5. **Cystites from Irritating Ingesta.**—Cantharides, turpentine, the balsams, phosphorus, corrosive sublimate, and an excess of alcoholic beverages are capable of producing a cystitis which may be simple, suppurative, or membranous. Certain articles of food will produce the same result in certain persons.

6. **Cystites from Surface-chilling.**—Exposure to cold and wet is a rare but undoubted cause of cystitis, which is usually mild in type, and especially attacks any bladder vulnerable from chronic congestion.

7. **Cystites from Trauma.**—Trauma applied to the perineum or hypogastrium may produce a cystitis independent of the introduction of germs through wounds. As sources of traumatism are also usually reckoned the pressure of pessaries, of fecal accumulations in the rectum, displacements of the womb anteriorly, and the pressure of the fetal head in childbirth. It is obvious, however, that in these cases trauma alone can rarely be held responsible; for example, in fecal accumulations the conditions are favorable for the migration of bacteria, while in uterine displacements and in childbirth septic conditions are often associated.

There is, furthermore, a purely traumatic cystitis produced by the rough use of perfectly aseptic vesical instruments. Such are, however, rare—much more rare, unfortunately, than the cases due to instrumental infection.

8. **Cystites from Irritating Injections.**—The injection of aseptic irritating chemical substances can produce a simple inflammation by their direct action on the mucous membrane, or may cause acute congestion by overdistention.

9. **Cystites from Descending Infection.**—Infection from the kidney and ureter is frequent. The infection may be by the urine, by the lymph-channels, or by contiguity from the tissue of the ureter. The importance of these cases lies in the fact that vesical treatment alone is not serviceable. Such cystites may be suppurative, phlegmonous, or membranous, and are often very severe in character. In some cases both kidney and bladder are simultaneously affected by metastatic infection.

10. **Cystites from Ascending Infection.**—Infection from the urethra, with or without urethral disease, is the cause of the great majority of cystites.

Infection from the urethra without urethral lesions is of common occurrence. In the infectious diseases, in states of profound systemic depression from any systemic disease, in intoxications, in nervous diseases, there may be retention of urine or retention with incontinence in which urethral infection occurs. It may even develop in simple incontinentia urinæ. The vesical infections occurring as sequelæ of stone, tumor, and prostatic disease are often of urethral origin. Whether or not the normal urethra always contains pyogenic micro-organisms is not yet settled: certain it is that they are sometimes present. It is certain that in the conditions just enumerated the urethra is usually healthy, while the bladder is ripe for infection. The modus operandi is, we admit, not clear, but it is certain that in many cases of this class infective cystitis occurs through a urethra not diseased, though it is usually due to instrumentation. Infection through the healthy urethra may also occur from deferentitis not secondary to urethritis.

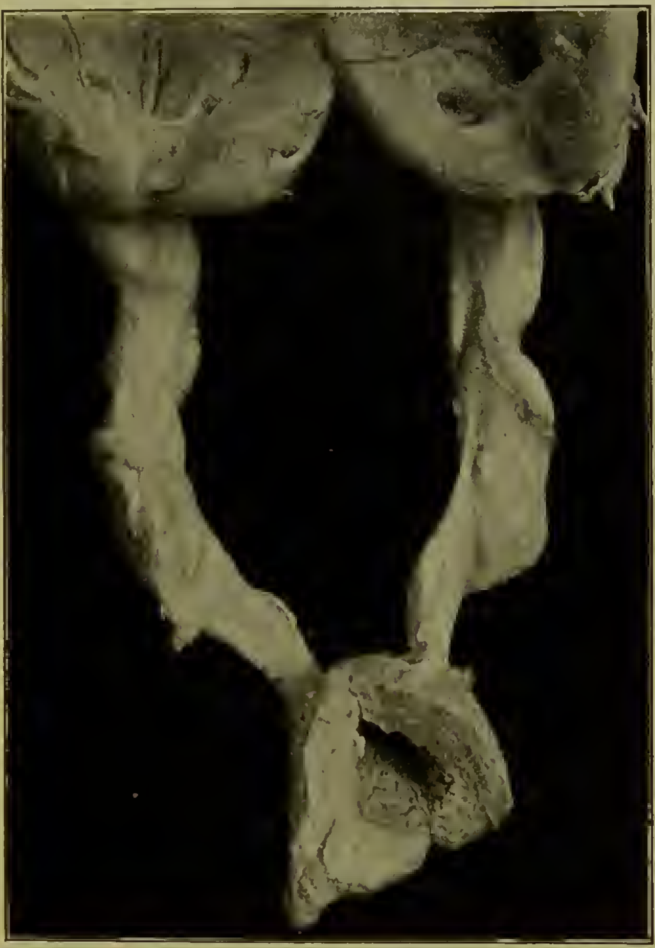


FIG. 106.—Urinary sepsis in an infant, secondary to stricture (Wistar Institute of Anatomy, Univ. of Penn.).

Usually the urethral cystites are associated with urethral disease. Septic infection may occur either in a healthy bladder or in a bladder made vulnerable by over-distention and retention of irritating urine.

Infection is common in gonorrhea. Probably pyogenic bacteria always play an important rôle, though it is useless to discuss this question when the urethral bacteria are so little understood as at present. In acute gonorrhea cystitis rarely occurs before the third week. It is caused by the passage of bacteria through the sphincter vesicæ or by extension in the mucous membrane or the submucosa. Sexual excitement and alcoholic beverages or highly stimulating foods by causing vesical congestion favor the ascent.

In chronic gonorrhea, especially when the prostatic urethra is deeply involved, infection, which occurs just as in acute gonorrhea, may be excited by trivial causes, as over-exertion, exposure to cold, etc. Here too venereal excitement and alcohol are often the provoking causes. Injections and the use of instruments are often the exciting causes of the cystitis.

Cystitis often complicates urethral stricture. Behind a fully-formed stricture conditions are favorable for the growth of bacteria, which may ultimately reach the congested and over-distended bladder, which, because of retention, is peculiarly susceptible to microbic invasion.

Any condition which diminishes the caliber of the urethra, such as paraurethral growths, may in like manner be complicated by cystitis. The cystitis of prostatic disease is classed under the vesical causes of cystitis.

Cystitis occurring during puerperal fever may be, from urethral infection, travelling directly from the vagina.

11. **Cystites from Vesical Conditions.**—Prostatic disease is the most important of these, particularly chronic prostatic hypertrophy. In any case of prostatic hypertrophy of long standing there is usually a congestion of the base of the bladder directly dependent upon the contiguous prostatic congestion, and wholly independent of general vesical congestion due to obstruction, retention, etc. In nearly all cases of marked hypertrophy there is more or less obstruction to the outflow of urine ; there is a consequent hypertrophy of the muscular coat, and some general congestion due to the increased muscular functions. When the relations between expulsive power and obstruction become such that retention of urine exists, there is an increase in the congestion. Should decomposition of the urea occur, the congestion will be markedly aggravated by the irritation of the alkaline urine. With a subsequent dilatation the conditions become much worse.

At any stage in the evolution of these vesical conditions septic infection per urethram may occur ; it is most likely to take place after retention of urine has been established. Very often there is some slight provoking cause, such as exposure to cold or wet, indulgence in alcohol, etc.

Tumors of the prostate can cause a cystitis in like manner.

Calculus is a common cause of cystitis : we refer, of course, to primary calculi of renal origin. Small smooth stones may produce no discoverable inflammation. As a rule, however, the mechanical irritation causes congestion or a mild degree of simple aseptic inflammation, really a traumatic cystitis. Infection per urethram may occur at any stage ; it is, however, usually late. After infection has occurred the cystitis of calculus may be violent, and deep ulcerations may occur. We have recently seen the specimens of a case in which the stone had ulcerated through the posterior bladder-wall and lay in front of the rectum beneath the peritoneum.

After ammoniacal decomposition of the urine has become established the stone increases rapidly in size from phosphatic depositions. The immediate cause of the vesical infection may be a chilling, a jolting of the body, etc.

Foreign bodies in the bladder and animal parasites are rare causes of cystitis.

Tumors of the bladder are nearly always complicated by cystitis, since the neoplasm invariably causes congestion, and there is present an abnormal tissue of low vitality. These conditions, associated with retention of urine and blood in the bladder, are most favorable to the development of bacteria ; hence septic infection often occurs early in the case. This is also true of tuberculosis of the bladder.

12. **Cystites from Instrumental Infection.**—Accidental infection of the

bladder, in both healthy and pathological conditions, is commonly produced by the use of unclean instruments. It is scarcely necessary to-day to insist upon asepsis in surgical procedures, even in the most trivial manipulation, such as catheterization. We must, however, urgently protest against the practice of sterilizing urethral and vesical instruments in strong solutions of corrosive sublimate, carbolic acid, etc., as the small quantity of such solution carried into the bladder may be sufficient to produce a cystitis from chemical irritation. Asepsis is demanded, not antisepsis.

Pathology.—The pathology of cystitis is to an extent complex, due largely to the peculiar circumstances which surround septic infection of the bladder per urethram. We are not yet fully in the light regarding the bacteria which cause cystitis. It seems to us an error to term all varieties of cystitis septic. There can surely be an aseptic inflammation of the bladder, just as well as of the liver—inflammation caused by the presence of dead cells which have been killed by chemical irritants, metabolic toxins, or trophic influences, etc. Even though in a number of cystites bacteria have been invariably found, this does not prove that in each of these cases the inflammation was first set up by bacteria.

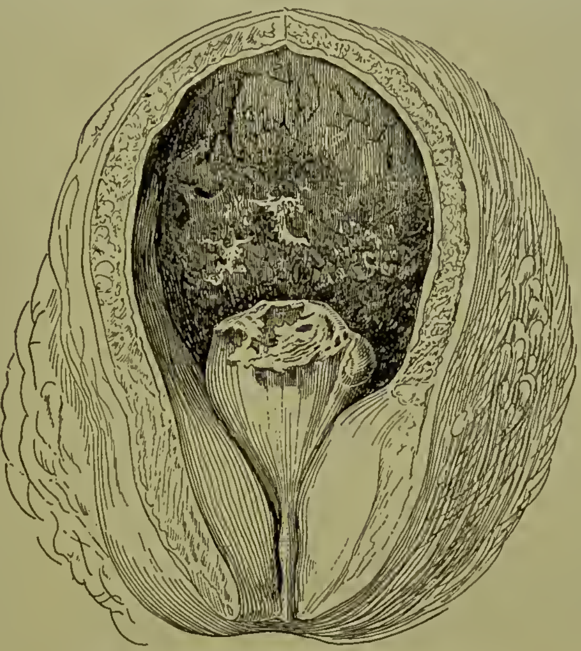


FIG. 107.—Prostatic hypertrophy (Orth).

The writers regard it as erroneous pathology to state that "congestion of the bladder," as the term is used in clinical surgery, and not as in exact pathology, predisposes to cystitis. Congestion is one aspect of inflammation; the chronically congested bladder is in a state of simple aseptic inflammation; there is doubtless always round-celled infiltration and the proliferation of connective tissue. Such a bladder is extremely predisposed to septic infection, and will become infected, but it must be recognized that prior to the moment of infection the bladder was, in the strict pathological sense, inflamed. The authors thus believe it justifiable to include under one heading all conditions of this class, some of which have been correctly described as congestions; and this heading shall be designated—

The Simple Aseptic Cystites.—These are very common. They are usually of short duration; should they not recover promptly, septic infection usually occurs. Three general groups of cases can be recognized: (1) Those caused by irritating substances in the urine, metabolic or ingested; (2) those due to disturbances in the function of micturition; and (3) those due to disturbances in the circulation incident to vascular or nervous conditions.

Of ingested substances which when eliminated irritate the vesical mucous membrane, the most important are cantharides, turpentine, the balsams, and bichloride of mercury. The hyperemia may be moderate, or so extreme that capillary bleeding occurs into the cavity of the bladder or into the tissues. Unless the poisoning be very intense or prolonged the inflammation remains aseptic.

Irritating injections cause a similar inflammation. Whether or not the simple cystites of the infectious disease are in part or entirely due to urinary alterations is a subject which we are not able to discuss. In certain constitutional diseases, however, not bacterial, perhaps dependent upon and certainly associated with marked metabolic disturbances, simple cystitis is not uncommon; as instances may be mentioned gout, diabetes mellitus and phosphaticus, idiopathic cystinuria and oxaluria, and scorbutus. It is known that ammoniacal urine is an active irritant to the bladder. The cystites of this group are often very mild and may remain uninfected for a long time.

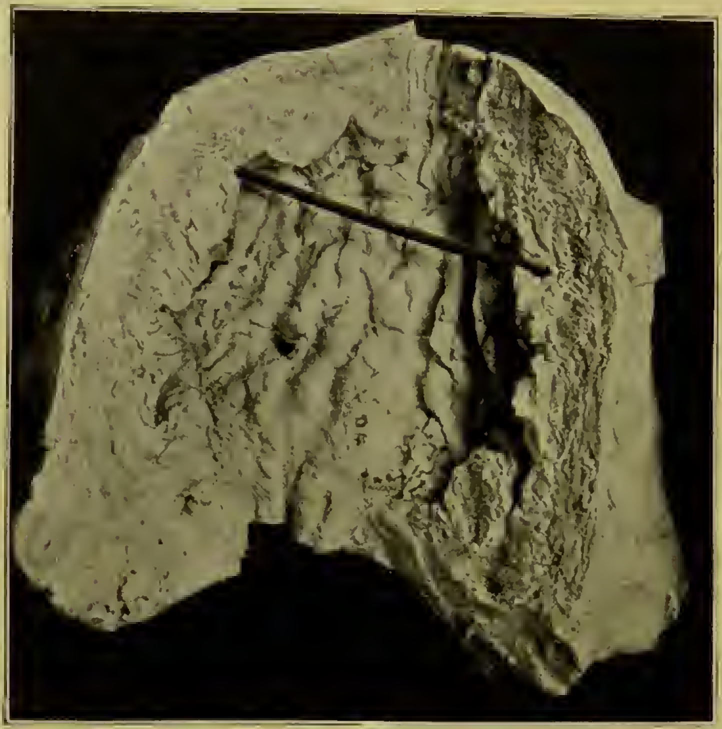


Fig. 108.—Hypertrophy of bladder with contraction of cavity, secondary to obstruction (Wistar Institute of Anatomy, Univ. of Penn.).

Disturbances in the functions of the urine provoke a more or less marked degree of hyperemia and simple inflammation. Over-distention of the bladder, either voluntary or pathological, the too frequent and superforceful contractions in the act of micturition, and retention, however slight, are the chief agents which contribute to the condition.

When the causes of the over-distention, retention, and obstruction are organic, septic infection commonly occurs, and often very early. In non-organic over-distention the condition is usually transient and septic infection rarely occurs. In the more persistent cases due to central vesical paresis septic infection is invariable.

Simple cystites due to disturbances of circulation of vascular or nervous origin are uncommon.

In extreme stagnation in the inferior vena cava passive congestion occurs in the bladder, with the production of a low grade of inflammation, as is seen in passive congestion elsewhere, often with considerable fibrous production. In severe cases the veins of the bladder may become varicose, especially at the base and neck, from which bleeding is not uncommon. The dilatation of these veins may be so extreme as to constitute an obstruction to the outward flow of urine. These cases sometimes become infected.

In disease of the central nervous system, especially in injuries to or inflammation of the cord, there is a most marked hyperemia of the bladder, vaso-motor in origin. Since they are usually associated with paresis of the muscularis, infection occurs early.

The presence of calculus and of the animal parasites also causes a simple inflammation which persists long and is very liable to become septic.

The **septic cystites** are, unfortunately, much more common than the aseptic cystites. In the infection of a bladder by pyogenic micro-organisms many factors play a rôle, some of occasional and others of constant importance. The general systemic condition of the subject has a distinct bearing on local infection. Local or general conditions which depress the health render the subject less able to resist microbic processes, and this applies very aptly to vesical infection. But the contrary is not true: even perfect health will not protect against infection of especial virulence.

The condition of the mucous membrane is of prime importance. Irritation of the epithelium or simple aseptic inflammation, however produced, predisposes most markedly to infection, and under such conditions even bacteria of mild virulence excite suppuration. Especially active are the processes of suppuration when the nutrition of the bladder has been altered by some diseases of the spinal cord; but the most healthy bladder may become infected by highly virulent bacteria.

The reaction of the urine is another important factor. Infection is much more likely to occur in a bladder whose urine is alkaline than in one containing acid urine. No doubt this occurrence is partly accounted for by the inflammation produced by ammoniacal urine and the precipitation of phosphates; but pyogenic bacteria also flourish better in such a urine than in normal acid urine. Acidity is, however, no hindrance to infection, since there are many cystites, and severe ones, in which the urine is always acid, provided there is no obstruction.

Disturbances in micturition are predisposing factors in the development of infection. We have seen that simple overwork of the muscular coat of the bladder will produce a mild inflammation. But it is in connection with obstruction and retention of urine that septic infection is almost invariable. Acute retention with over-distention produces a severe simple inflammation, which if properly treated does not, as a rule, result in infection. It is chronic partial retention, the condition in which there is always a residue of urine in the bladder, which so inflames the organ and lowers its powers of resistance that infection occurs. These conditions are typically seen in prostatic hypertrophy and urethral stricture and in some cases of vesical stone or tumor.

Retention alone will produce cystitis, but not suppurative cystitis; alkaline urine alone may produce cystitis, but not suppurative cystitis. This fact has been made very clear by animal experimentation. The sole causes of suppuration are bacteria introduced from outside the bladder, generally through the urethra. The above conditions modify infections, but while highly favorable to its development, they are not essential, since suppurative cystitis can be produced by the injection of virulent pyogenic bacteria into a healthy bladder. It is commonly stated that the presence of blood or albumin in the urine favors the growth of bacteria; and while this assertion may be true in the laboratory, it is doubtful whether it is of much importance, since with hematuria or albuminuria some one or other of the above-mentioned conditions favorable to infection are usually present.

The Bacteria of Suppurative Cystitis.—A great variety of bacteria have been found in the pus of cystitis. For many of them it has not been shown that they stand in any etiological relation to the suppuration.

The forms which have been shown to be present, and whose pus-producing faculty is known, are the following:

The staphylococcus pyogenes aureus, albus, and citreus, which also possesses the power of decomposing urea.

The streptococcus pyogenes.

The various members of the family of bacterium coli commune. These have been shown to be of especial importance in the cystitis of retention. Whether or not these bacilli can break up urea is not definitely known. Certainly their power must be weak, since in suppurative pyelitis, which is commonly caused by them, the urine is usually acid.

The proteus vulgaris. This form also possesses the power of breaking up urea, with the production of the ammoniacal reaction. When such decomposition is present in cystitis due to other bacteria, it is caused by saprophytic micro-organisms, of which the most important is the micrococcus urea, though four other forms have been described by Leube and Glazer.

It is thus evident that ammoniacal decomposition is not necessarily a result of cystitis *per se* (apart from that caused by the proteus vulgaris and the staphylococcus); that it may and often does antedate suppuration; and that suppuration may and does occur without it.

A very rare form of bacillus is the urobacillus liquefaciens septicus.

The gonococcus alone is perhaps not capable of producing a vesical suppuration; at least it has been impossible to produce suppurative cystitis by intervesical injection of cultures of the gonococcus supposed to have been pure, and to have been the real gonococcus. Nevertheless, since it has been conclusively shown that the gonococcus can produce septic internal inflammations—endocarditis, pleuritis, lymphadenitis, for example—it must not be held that it is incapable of producing suppurative cystitis.

The tubercle bacillus produces a form of chronic inflammation peculiar to itself, and it has been consigned to a special description elsewhere.

The Lesions of Suppurative Cystitis.—These are many and varied; as a rule, no one form of lesion exists alone. For the sake of clearness and brevity they will be described separately.

In simple *catarrhal* suppuration there is during life more or less congestion, which, as a rule, does not persist post-mortem. In very acute cases the hyperemia is intense; in chronic cases the color may be no more deeply pink than in health. The surface of the mucous membrane is covered with a thick coat, which may be very tenacious, very rich in pus-cells and epithelium.

Blood may be present, usually only the faintest trace. There may be minute hemorrhages in the acute form; in the chronic form of simple catarrh they are rare. They are especially common in the cystitis of scorbutic patients and in those complicating severe cases of infectious diseases. They are usually confined to the mucosa, and appear in the form of minute points of extravasation.

There may be marked edema of the mucous membrane in violent acute cases, and this may be so extreme that the tissues may be torn by the pressure, and then the serum collects under the epithelium in the form of small blebs. There is round-celled infiltration beneath the epithelium, particularly along the lines of the capillaries. The epithelial cells may be more or less swollen, and present a cloudy appearance or the first signs of fatty degeneration.

In *chronic catarrhal* cystitis the formative changes are usually very marked. The mucous membrane becomes thickened by reason of round-celled infiltration and the conversion of this into fully-formed connective tissue. The vessel-walls likewise show a proliferative periarteritis. The overgrowth of the mucous membrane is often not regular, and this fact, when taken into connection with the hypertrophy of the muscularis and the contraction of the bladder, explains the rugous appearance often seen.

The epithelium may be thickened by excessive cell-proliferation or may be thinned by degenerations. In all cases there is abnormal degeneration of the cells, usually fatty in character, with indistinctness of the nuclear chromatin. Often the epithelial proliferation may be so active that villosities are formed—tiny excrescences composed of a capillary stalk surmounted by epithelium, and readily bleeding. The fungo-vascular structures upon which Albarran has laid especial stress are of the same formation, except that they are larger and more vascular, being, in fact, sometimes almost telangiectatic.

Mucous polyps are also seen; in these the vascular elements are less pronounced, while the epithelial overgrowth is such that they quite resemble papillomata. Retention-cysts are common; they are usually small, and may be composed of involutions of the superficial epithelium or of obstruction to the outlet of the submucous glands. True cystic formations are rare, and occur at the base.

Entirely different in appearance are the hypertrophied lymphatic follicles of the mucosa, which in chronic cystitis become so enlarged that they can be both seen and felt as hard, round clumps in or just beneath the mucous membrane. They are most marked about the base and neck, and have been mistaken for tuberculosis.

Hemorrhage in chronic cystitis not complicated by ulceration is rare. Should it have occurred and the urine be alkaline, there will be a dirty-brown deposit upon the mucous membrane. The coating of detritus, pus, and epithelium and nucleo-albumin is much more marked than in the acute inflammation, and, when the urine is alkaline, very tenacious. There is usually more or less of an incrustation of this covering with phosphates.

Membranous (diphtheritic) formations are not rare in cystitis. There is exceptionally a fibrinous transudation not connected with tissue-necrosis, but this is unimportant, except that it may block the opening of the urethra.

The true membranous formation occurs most often at the trigonum, and, even when universal, usually starts from this region. There is a superficial necrosis of the mucosa; a transudation occurs beneath this, breaks through it, and covers it, and the whole is then converted into a membrane by the formation of fibrin. When such membrane becomes detached, another promptly forms upon the area, while the detached mass may obstruct the urethra.

Hemorrhage is usually marked in connection with diphtheritic processes; indeed, it is often over the site of a hemorrhage that the initial necrosis begins. If the formation occurs about the neck, the urethral orifice may be much narrowed or entirely closed. The color of the membrane is usually of a reddish gray; this will, however, be modified by the amount of blood present. The membrane may become incrusted with triple phosphates, and when such a membrane becomes detached and rolled up, it may be mistaken for a calculus.

Membranous formations occur mostly in the cystitis of cord-disease or injury and in those which complicate the acute infectious diseases; but they may develop in any bladder-inflammation, especially that of severe cantharides-poisoning.

Ulceration is very frequent both in acute and chronic cystitis. It may form at the site of a hemorrhage. Usually it begins in an area of extreme desquamation, mostly at the base. Such ulcers are commonly shallow; their edges are rough and elevated, their bases are formed of the thickened submucosa. In chronic cases they may penetrate to or even through the muscular coat.

Hemorrhage is frequent from such ulcers, and they are often covered with a crust of salts colored by blood-pigment.

In some cases the suppuration assumes a virulent character, and burrowing from the ulcerations produces a *phlegmonous* cystitis. This burrowing may be lateral between the coats of the walls, or it may be centrifugal, with the frequent production of perforation, the intramural abscesses opening again into the bladder-cavity. Such cases are characterized by rapid tissue-disintegration, with little attempt at round-celled infiltration or fibrous formation. Should the perforation occur through the vault, a peritonitis is inevitable; should it occur at or about the base, which is more common, a phlegmonous paracystitis will be produced.

The most virulent forms are seen in the cystitis of myelitis, complicating acute infectious diseases, and occurring late in the course of prostatic obstruction.

In exceptional cases the process becomes *gangrenous:* there is little pus formed, but large areas of the bladder-wall slough. Such cases are nearly always in connection with cord-diseases. We have no knowledge bearing upon the bacteriological aspects of these various processes.

There is a rare ulceration of the bladder, not associated with ordinary cystitis, described by Rokitansky under the name of simple perforating ulcer of the bladder. It consists of a small ulceration at the base which has a cut-out appearance and advances rapidly to perforation. Nothing is known as to the etiology or pathology of this condition.

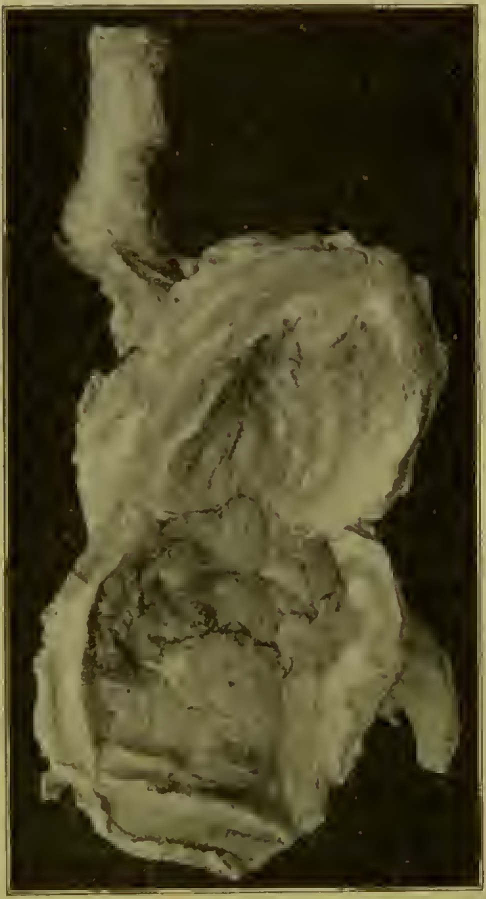


Fig. 109.—Gangrenous cystitis secondary to calculus (Wistar Institute of Anatomy, Univ. of Penn.).

Syphilitic ulceration of the bladder is almost unknown.

The contents of the bladder in severe cystitis deserve a moment's description. Calculi are often present—formations secondary to the precipitation of salts by the ammoniacal reaction. They are usually small, but may be of extreme size.

When the urine is markedly ammoniacal and a large amount of pus is present, this in the presence of sodium chloride and ammonium carbonate becomes converted into a gelatinoid mass which is difficult to void. In a few rare cases pneumaturia has existed; the gases were CO_2,H or H_2S, or N, probably produced by special bacteria.

In nearly all cases of chronic cystitis hypertrophy of the muscular coat occurs. It develops early, and is pronounced in those cases in which the cystitis is secondary to obstruction. It occurs in all other cases as the result of the disturbed micturition. Late in the cases of obstruction the muscular wall may become so weakened by fatty degenerations that dilatation occurs. In other cases there is fibrous overgrowth, causing contraction and muscular atrophy. This thickened, contracted bladder with ribbed mucous membrane is a familiar condition in old cystitis.

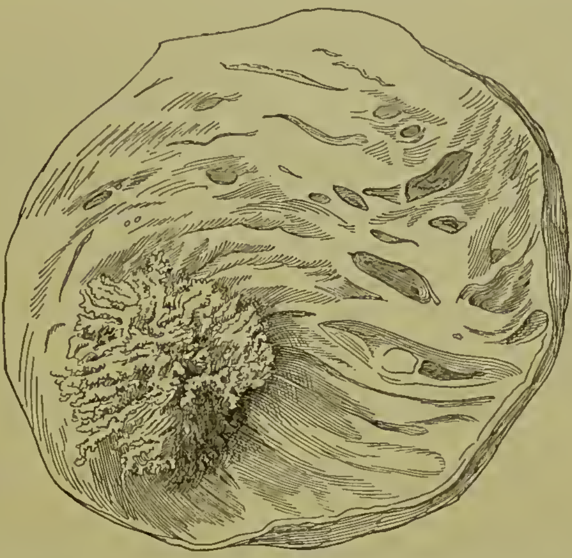


FIG. 110.—Tufted inflammation on the posterior wall of the bladder, which shows a muscular hypertrophy (Orth).

In some cases the contraction of the bladder seems to have been irregular, and sacculations are produced. These may be large, and several may coexist. They form a favorite lodgement for calculi.

Another uncommon condition seen in cystitis is false diverticulum. This is supposed to be produced by a break in the muscularis, so that a portion of the mucous membrane projects through it to the perivesical fibrous tissue. Such diverticula may be as large as the bladder-cavity itself, and have not infrequently been described as double bladder. They are usually posterior.

In some cases of obstruction, where the dilatation of the ureters is extreme, the appearance of the base may be much distorted by the opposing forces of fibrous contraction of the base and ureteral dilatation.

Pericystitis implies inflammation of the tunica adventitia of the bladder. Paracystitis is inflammation of the tissues surrounding the bladder.

Paracystitis can arise from within the bladder or from without. In the majority of cases paracystitis is secondary to extreme ulceration or phlegmonous suppuration, with or without actual perforation. In rarer cases it occurs by lymphatic or vascular transmission or by bacterial migration through a normal or even hypertrophied wall.

Paracystitis due to extra-vesical infection may be secondary to peritonitis, intestinal or rectal ulcerations, pelvic abscesses due to genital or bone diseases, etc. This inflammation may develop behind or in front of the bladder, or laterally in the connective tissue. When pus is formed, it may open into the bladder, into the rectum, or may burrow in the lines of least fascial resistance.

The *urinary signs* vary greatly with the reaction of the urine. In those cases where the reaction is acid the appearance of the urine is little changed, a slight turbidity being the only macroscopic departure from normal. Upon standing a whitish sediment collects and the supernatant urine becomes clear.

The quantity of urine in cystitis varies according to the other conditions or diseases affecting the patient, and especially according to the condition of the kidneys. There is a true polyuria of vesical irritation, but frequent micturition must not be interpreted to mean polyuria.

Albumin is present in all cases of pyuria, but may not be demonstrable by clinical methods. It may be desirable in a given case to determine whether an albuminuria be due solely to a pyuria or to an associated nephritis. Posner has found that 1 per cent. of albumin in the filtered urine, estimated by Esbach's method, corresponds to 100,000 pus-cells in 1 c.mm. of the mixed undiluted urine counted by a Thoma-Zeiss blood-counting apparatus; should the relation be much higher than that—for example, 1 per cent. albumin to 10,000 or even 50,000 pus-cells per c.mm. urine—a renal albuminuria is indicated. The quantitative estimation of serum-albumin and globulin in the urine (as given in the section on Tumors of the Bladder) may also be made in a doubtful case.

Should blood be present in quantity sufficient to complicate the diagnosis, Goldberg's method could be employed to eliminate or diagnose a renal albuminuria.

Sugar is, as a rule, not present; mild cystitis is, however, frequent in diabetes.

When the urine is neutral or ammoniacal the entire appearance of the urine is changed. It is turbid, contains tenacious flocculi of altered pus; there is a large amount of precipitated salts and detritus; on standing a heavy sediment forms, but the supernatant urine does not become clear. There is a disagreeable odor to the urine; it may be ammoniacal, it may be fermenting. The albumin-tests do not respond so sharply as in acid urine on account of the turbidity: for careful testing a little of the filtered urine should be carefully warmed, and then brought back to a faint acid reaction by dilute acetic acid; then strongly acidulated and tested with a solution of potassium ferrocyanide.

The sediment contains the most important signs. Pus is present in all cases of septic cystitis. The quantity varies greatly, and, estimated from day to day in samples taken from the well-mixed twenty-four-hours' urine, the quantity furnishes valuable evidence of the intensity of the infections. In mild cases there may be no more than 500 pus-cells in the c.mm. of mixed urine; in very severe cases the discharge may be so excessive that there may be 150,000 in the c.mm. When we consider that in such a case 150,000,000,000 pus-cells are discharged in every twenty-four hours, while as a liberal estimate there are not over 150,000,000,000 leukocytes in the circulating blood, we are brought to consider the astounding powers the lymphatic tissues must possess.

The counting of pus-cells is often difficult or even impossible in strongly alkaline urine; as before mentioned, the pus becomes gelatinous and cannot be well mixed into the urine. The pus-cells are polymorphous leukocytes, and contain, as a rule, neutrophilic granulations, rarely oxyphilic. They are often more or less degenerated, particularly in decomposed urine.

The blood in the urine of cystitis is usually trivial in amount. It may, however, be profuse, and clots may form in the bladder so large that they are voided with difficulty or not at all. In acid urine the blood-cells are usually well formed, though always crenated: in decomposed urine they may be fragmented.

Vesical epithelial cells are present in the sediment of the urine of all cases of septic cystitis; they are usually of the superficial layers, but in severe cases the deeper cells (ovoid or cylindrical with one or more processes) may become desquamated. These cells are usually badly degenerated. We do not believe that it is possible to distinguish these cells from those of the ureter.

Fragments of tissue, necrosed mucous membrane, or even portions of the deeper tissues, are sometimes seen, especially in trophic cystites. They should be carefully distinguished from fragments of neoplasms.

The crystalline sediment consists of a moderate amount of amorphous phosphates, amorphous or ammonium urates, and large quantities of triple phosphates. The crystals of ammonium urate are dark balls which may be spiculated; the triple phosphate commonly appears in the form of slab-shaped crystals; there may, however, be needles, squares, and many forms of irregular crystallization.

Tube-casts will be present in all cases complicated by nephritis. Hyaline casts and cylindroids can be found in the freshly centrifugated sediment in many cases which show no signs of renal disease.

Cultures of the bacteria may be made upon blood-serum and agar and upon bouillon, from which plates should be prepared. In all doubtful cases the tubercle bacillus should be carefully sought for—by injection-experiment if necessary. If no culture-media be at hand, one can be made by adding to fresh urine some of the numerous preparations of hemoglobin for internal administration; and this, too, is a medium upon which the gonococcus can be grown.

Symptoms.—The symptoms of cystitis are local and constitutional. Both are more likely to be severe in acute cystitis. The severe constitutional symptoms of chronic cystitis are many, due to the complications, especially secondary renal lesions.

Pain is an early and quite constant symptom. There is pain not connected with micturition—a deep ache over the pubis or in the perineum: such pains are more often seen in the acute cases, and are especially marked in the aseptic inflammations which follow sudden distention and the ingestion of substances whose elimination irritates the bladder. These pains do not radiate.

The pain connected with micturition is of more importance. A common form is a burning in the urethra during urination, often especially severe at the meatus. At the close of micturition the pain may become somewhat colicky in character. It may cease directly the act has been completed or may continue for some time thereafter.

Another form of pain is that of a distressful straining. This precedes the act of urination, is a deep spasmodic pain, and is relieved by voiding the urine. Whenever the urine contains large clots of blood, or whenever excessive ammoniacal decomposition renders the pus so gelatinoid and tenacious that it can with difficulty be voided, a colic is produced—at first urethral, but later vesical if the obstruction does not yield.

The pains connected with micturition are usually severe in proportion to the severity of inflammation and the frequency of micturition, but there are notable exceptions to this rule. Pain is likewise more marked in cases with obstruction than without, but to this rule there are also exceptions.

Cystitis due to or complicated by stone may commonly excite the pain characteristic of that condition—*i. e.* most severe at the end of micturition. There is said to be great pain in the parasitic cystites which occur in the tropical regions.

When renal involvement has occurred, especially if connected with ureteral and pelvic dilatation, the pains of these conditions, especially those of nephro-ureteral colic, are added to the case.

There is in many cases a para-anal pain: this may be a part of a sympathetic anal tenesmus, but in some cases is quite constant and independent of anal tenesmus.

The pains of paracystitis depend entirely upon the position of the inflammation and the direction of burrowing. In many cases there are vague pains down the inner aspect of the thighs, but whether these are radiated or referred is not known.

The condition of the vesical tension has a marked influence upon the pain, which is usually most severe when the organ is either full or empty, and is often proportionate to the degree of dilatation.

The condition of the urine also exerts a marked influence: pain is usually moderate so long as the urine is acid. When it becomes alkaline the pains are augmented, particularly the urethral pains, and are usually proportionate to the intensity of the ammoniacal decomposition. Ulceration also has a bearing on pain, since the ulcerated surface is, as a rule, more sensitive to the irritation of ammoniacal urine and the precipitated salts than the inflamed mucous membrane. In the rapid necrosis of cord-diseases or injuries pain is usually not marked, and with anesthesia below a certain cord-segment is of course absent.

Disturbances in the Act of Micturition.—Unusual frequency of micturition is present in all cases. In mild cases, particularly when the urine is acid, the daily number of micturitions need not much exceed the normal. Early in the case the abnormal frequency may be limited to the waking hours; later, however, even the patient's night is disturbed, and sometimes scarcely less than his daytime.

The causes of frequency are threefold: The reflex influences of an inflammation of the vesical mucous membrane are alone able to provoke frequent micturition. In an analogous manner the irritation of ammoniacal urine and of precipitated salts effects contractions of the organ. In the cases of obstruction the partial retention powerfully excites the detrusors. Thus the condition of frequent micturition is usually worse in the contracted bladders of prostatic obstruction. In calculous cystitis exercise usually aggravates the condition.

Tenesmus is frequently present. A small degree of tenesmus is constant in all marked cases of increased frequency. In some cases it becomes exaggerated and remains almost constant, and, goaded by its intense pain, the patient is almost constantly attempting to force a few drops of urine from a bladder which may be entirely empty. In these cases a reflex rectal tenesmus is excited which aggravates the already miserable condition. It should be mentioned that, inversely, a full rectum excites vesical tenesmus and frequency of urination.

The general symptoms of cystitis are usually not marked and are often entirely absent.

Fever is common in acute cystitis; it may range high and may be associated with chills and sweating. In chronic cystitis, with free drainage of the pus, fever is rare. Persistent elevation of temperature in a chronic case indicates either an aggravated acute exacerbation, paracystitis, prostatitis, or, most commonly, extension to the ureters and kidneys. Fever should never be attributed to inflammation of the uro-genital tract until the possibility that the cystitis might be due to one of the general diseases already mentioned has been excluded. The fever of paracystitis is liable to be more constant than that of suppurative uretero-nephritis, which is often markedly intermittent.

The gastro-intestinal tract of nearly all cases of chronic cystitis is more or less disturbed. Anorexia, distress after eating, eructations of food or gases, and constipation are common complaints. In severe cases the loss of sleep consequent upon nocturnal tenesmus and frequency of urination may reduce the subject to a miserable condition of nervous weakness.

There is another group of nervous symptoms which are often severe, and may be of sudden or gradual onset—headache, vertigo, temporary mental aberration, paroxysmal vomiting. These are most pronounced in cases exhibiting extreme ammoniacal decomposition of the urine, and it has been suggested that they may be due to the resorption of products of decomposition—sulphuretted hydrogen, ammonia, etc.

In such cases, however, the surgeon should suspect uremia; renal symptoms are indeed very common. The renal lesions are those either of suppuration from ascending infection or of mixed nephritis, the parenchymatous element predominating in some cases, the interstitial element in others. Healthy kidneys in a case of chronic cystitis are almost unknown; it is in the obstructive cases that the renal lesions are most destructive.

The symptoms of renal suppuration may appear at any time in the course of chronic cystitis; a cold or an exacerbation of the cystitis may seem to have induced them. These symptoms are, as a rule, insidious. Dropsy is generally slight; there are often symptoms of arterio-sclerosis and cardiac hypertrophy; dyspnea and gastric irritability trouble the patient, who suffers additionally from a great deal of headache. Violent outbursts of acute uremia are not uncommon, but mild chronic uremia is much more frequent.

When suppurative paracystitis sets in, the process may be limited by adhesions, but usually there is absorption at least of toxic substances, with the production of septicemia and the pronounced symptoms of internal suppuration, or even of the bacteria themselves, with the production of pyemia.

Prognosis of Cystitis.—The prognosis of cystitis when it is not due to infection is good. The disease subsides in a few days or at most one or two weeks, and has no sequelæ beyond slight vesical irritability and tendency to renewal of acute congestion from trifling causes.

When inflammation of the bladder is due to infection, prognosis must always be guarded. In the absence of irremediable urethral obstructions most patients recover more or less completely. Exceptionally—and it is impossible to predict the exceptions—the inflammation ascends along the ureters and involves the kidney pelvis and the kidneys, causing pyelitis and pyelo-nephritis. This backward extension is much more likely to occur when cystitis is complicated by retention of urine. It may happen, however, in the absence of retention, and is more likely to occur during the early acute stage of inflammation.

It is a commonly accepted doctrine that ureteritis and pyelitis are dependent in the main upon the purulent contents of the bladder being forced into the ureters. This can scarcely occur unless the bladder is full of urine and the urethral outlet is closed or at least obstructed. It is maintained that ascending infection is more common in the early stages of acute cystitis, because at this period the vesical muscles still retain their power, and by their vigorous contraction force a portion of the bladder-contents back into the ureters when the latter are reflexly opened during the downward discharge of the secretion of the kidney.

The writers believe that ascending infection is not due to reflux, but that it travels by continuity of tissues; that it is more likely to reach the kidneys when the bladder is over-distended, because this condition engenders great congestion of the entire urinary tract, and hence predisposes it to sepsis; that the infection is likely to ascend early, because this represents the period of greatest virulence of the germs and most pronounced reflex congestion from functional disturbance. The variety of germ-infection has a distinct bearing on prognosis. The colon-bacillus group seems to be the most virulent and tenacious, and is most likely to invade the higher urinary tract. The gonococcus very exceptionally reaches the kidney. The germs of ordinary suppuration in the absence of distention remain limited to the bladder and cause less severe forms of inflammation.

The prognosis of parenchymatous cystitis is grave. Intramural or paracystic abscesses may form, resulting in septicemia or pyemia. The musculature of the bladder is always seriously affected, the disease in its involution producing an incurable thickening, rigidity, and cicatricial deformity, which may absolutely incapacitate the bladder as a reservoir.

The prognosis of pseudo-membranous cystitis is fairly good. This disease is rarely recognized until exfoliated shreds of membrane are passed through the urethra. The chief danger is that incident to obstruction from these shreds; if this is relieved by prompt cystotomy, the patients usually recover, often with functional bladders, although muscular fibers may be found in the exfoliated tissue.

The prognosis of gangrenous cystitis is practically hopeless.

Diagnosis.—It should be remembered that none of the symptoms usually considered characteristic of cystitis—*i. e.* pain, frequent micturition, and pyuria—are necessarily indicative of this condition, since they all may be caused by inflammation of the prostatic urethra. It is also true that a deep and progressive cystitis may be present without a single subjective symptom. As a rule, however, inflammation of the bladder can be readily determined. In acute cases there is distinct tenderness on suprapubic and rectal palpation; there is a superabundance of epithelium; the urine contains more pus than is common in urethritis; the last portion passed is as turbid or even more so than the first; intravesical injections show that the bladder is extremely sensitive to tension; an instrumental exploration, providing this is considered advisable, will show the hypersensitiveness of the mucosa to direct palpation.

In chronic cases there may be neither sensitiveness to pressure nor any other characteristic symptom; the urine is, however, always purulent, and is often ammoniacal, though not necessarily so.

It may happen when the urine is acid, and when vesical symptoms are not pronounced or are entirely absent, that it may be extremely difficult to determine whether the pus is of vesical or of renal origin. In renal suppuration there is usually renal albuminuria, and hyaline casts are commonly found. It is, however, very often impossible to determine the source of the pus, excepting by cystoscopic examination. This is serviceable in determining the character of the inflammation and its seat of greatest intensity, thus enabling the surgeon to make a rational selection of the treatment most likely to be serviceable.

The diagnosis of a gangrenous cystitis, which sometimes occurs in the course of acute fevers, may be suggested by the passage of necrotic shreds and the foul odor of the urine. Membranous cystitis is usually not suspected until the advent of acute retention calls for operative interference.

Treatment of Cystitis.—**Acute Cystitis.**—The underlying principles in the treatment of acute cystitis are—(1) To render the urine bland and slightly antiseptic; (2) to put the bladder at rest and relieve pain; (3) to lessen pelvic congestion.

When inflammation is strictly confined to the bladder and is superficial, as is the case ordinarily in acute cystitis, excepting when this attacks a previously diseased viscus, there are no constitutional symptoms, and hence treatment directed to the relief of fever and its concomitant phenomena is not indicated.

The urine is rendered bland by the ingestion of large quantities of hot water and a milk or buttermilk diet. If it is strongly acid, as is often the case in the gouty or rheumatic cases, a vegetable acid or an alkaline preparation may be administered. We have found that the best method of diluting the urine is to give milk and Vichy or other effervescing alkaline mineral water, mixed in equal proportions. This is extremely digestible, and is likely to correct gastro-intestinal disturbances. Four ounces of milk and an equal quantity of the effervescing water should be ingested every two hours, making in all about sixty-four ounces of fluid a day, since it is not necessary to disturb the patient during the night for the purpose of giving him nourishment. When the milk disagrees, causing biliousness and constipation, koumyss or koumyssgen or buttermilk may be given with Vichy.

For the purpose of rendering the urine slightly antiseptic small doses of salol are administered, 5 grains three times a day. In these small doses the drug does not interfere with digestion and prevents intestinal fermentation. It is eliminated through the kidneys in the form of carbolic acid. Exceptionally, patients exhibit an idiosyncrasy toward the salol. In these cases boric acid (10 grains thrice daily) may be substituted.

When diluents do not sufficiently counteract acidity, citrate of potassium (10 grains three to six times daily), well diluted, bicarbonate of soda (20 grains six times daily), or lithium citrate (10 grains six times daily) may be administered, but not to the point of making the urine decidedly alkaline.

Pain when constant and harassing should be controlled by opium. This is best administered in the form of either suppositories or hypodermic injections. In either case the narcotic is advantageously combined with belladonna or one of its derivatives. There is no routine dose, the narcotic being pushed until its end is accomplished—*i. e.* the relief of pain. The prescription we commonly employ is the following:

℞. Extract. opii aquas.,	gr. 1;
Extract. hyoscyami,	gr. $\frac{1}{4}$;
Ol. theobrom.,	gr. 15.

Make 1 suppository.

Sig. Administer one such suppository every hour until pain is relieved.

As further means of combating pain the various methods shortly to be described by which pelvic congestion is lessened are serviceable, and indeed may be so efficacious that a narcotic will not be needed.

In certain cases of gonorrheal cystitis attended by veritable anguish the inflammation is mainly limited to the prostatic urethra and vesical trigonum. The suffering is so severe that it is unrelieved by opium, even though this drug be pushed to the limit of safety. The patient is exhausted. Under these circumstances instillations may prove serviceable. Fifteen drops of 4 per cent. solution of cocaine injected by means of an instillator, the point of which is carried within the grip of the compressor urethræ, will be followed by relief of pain which will last for several hours. Ten drops of a 5 per cent. solution of silver will produce the same effect. The action of the cocaine is readily understood. No explanation is offered for the almost immediate and often permanent relief following instillation of silver. This treatment is given simply on the basis of clinical experience.

Hypodermics of morphine are indicated when opium suppositories produce obstinate constipation.

The bladder is best put at rest by opium and belladonna suppositories; in certain aggravated cases, where full doses of these drugs fail to relieve, where the inflammation is steadily advancing in spite of careful palliative treatment and instillations simply aggravate the suffering, we believe the dangers of ascending infection or interstitial inflammation will be lessened by continuous catheterization practised in the manner described in the Treatment of Chronic Cystitis.

Pelvic congestion is lessened by putting the patient to bed with the pelvis elevated, the thighs flexed on the body, and the knees supported on a pillow, securing regular evacuations from the bowels by either salines or cold normal saline enemata, drawing the blood to the surface by counter-irritation applied over the pubis and to the perineum, rendering the urine bland, and relieving vesical spasm by anodynes.

Counter-irritation may be applied in the form of blisters, which should be small and repeated. Hot fomentations, changed every hour, are more serviceable and less disturbing. Turpentine stupes and mustard plasters applied to the suprapubic region are also efficacious.

Hot general baths or hot sitz-baths are powerful revulsives, and often so relieve the spasm and congestion that the patient remains comfortable for hours afterward, and is able to void his urine almost without pain. Exceptionally, leeches may be applied to the perineum and above the pubis.

The treatment thus outlined—*i. e.* rest in bed with a liquid diet and urinary antiseptics, regular evacuation of the bowels, counter-irritation, and the use of hot baths—is usually all that is required during the acute or hyperacute stage of cystitis, unless there be retention of urine either from congestion, spasm, or obstruction of the urethra by clot, calculus, tumor, or other body; when this occurs the indication for relief of obstruction is imperative, since tension in an acutely inflamed bladder is the most favoring factor in the development of an ascending pyelo-nephritis. The retention is best relieved by permanent catheterization. Should this prove insupportable, there should be no hesitancy in performing perineal cystotomy and draining through this opening. The method of dealing with blood-clots is described elsewhere.

On the subsidence of acute inflammation a treatment somewhat more active than that outlined may be instituted. The urine may be rendered not only antiseptic, but stimulant and astringent; the bladder may be treated directly by antiseptic lotions. Of the long list of medicines which have been given by the mouth for the purpose of hastening the resolution of inflammation of the bladder, but few are really serviceable. The drugs which have given the authors the best results are sandalwood oil, copaiba, gaultheria, salol, saw-palmetto, and pichi extract. These may be given in the following prescriptions:

℞. Ol. santal.,
Balsam copaiv.,
Ol. cinnamom., *āā.* ♏v.
Ft. capsul. No. j.
Sig. Take one hour after meals thrice daily; gradually increase to six a day (two after each meal).

℞. Ol. gaulther.,
Balsam copaiv., *āā.* ♏v.
Ft. capsul. No. j.
Sig. Three to six capsules daily, after meals.

℞. Saw-palmetto (berries), gr. xv;
Ol. santal., ♏v.
Ft. capsul. No. j.
Sig. One capsule thrice daily, one hour after meals.

℞. Ex. pichi, gr. v.
Ft. capsul. No. j.
Sig. Three to six daily, after meals.

If the urine is persistently alkaline, this may be corrected by benzoic acid.

The treatment of the declining stage of cystitis is particularly important, since the disease commonly exhibits a tendency to become chronic. The change from liquid to solid diet should be gradual; there should be no hurry in getting the patient out of bed, and the urine should be carefully watched to see that it becomes neither markedly acid nor alkaline.

The direct bladder-treatment has for its end the washing out of decomposing and hence irritating urine. By no possibility can an antiseptic be so employed that it will thoroughly disinfect the bladder-walls. It can and does stop fermentation and decomposition, and can be made to replace a fluid which is keeping up irritation. It is essential that the surgeon should clearly understand the limitations of irrigation and the object for which this treatment is applied.

In the treatment of acute cystitis bladder-washing is never indicated when the urine is bland and the bladder is thoroughly evacuated by the act of micturition. Should there be retention and decomposition, as shown by the passage of foul, ammoniacal urine, irrigation is indicated even at the height of the severest form of inflammation. Since the irrigating fluids are solely for the purpose of disinfecting the discharge in the bladder and preventing fermentation, they should be so selected that they do not add to the existing inflammation. This implies the choice of weak lotions. Those which are most serviceable are normal salt solution .7 per cent., permanganate of potassium 1 : 12,000, creolin 1 : 500, boric acid 1 : 100.

The irrigation may be practised with a short urethral nozzle or with a soft catheter. When there is still dysuria with pain the catheter is preferable. When the patient micturates with comparative ease and comfort a short urethral nozzle should be chosen.

The method of conducting irrigation is as follows: The patient is first instructed to empty his bladder; he is then placed in the dorsal decubitus; an irrigating-bag containing 1 pint of the lotion at blood-heat is hoisted eight feet above the bladder, and the nozzle, shaped like a flattened cone or the extremity of the ordinary gonorrheal syringe, is attached to the end of the pipe leading from the bag. The fluid is allowed to flow through this nozzle, and is first directed against the glans and the lips of the meatus, which are held apart by the thumb and finger of the surgeon. The tip of the nozzle is then introduced into the urethra, the meatus-lips being pressed against it laterally. The solution is allowed. to flow until the anterier urethra is thoroughly distended. The stream is then cut off, and the fluid contained in the urethra is allowed to escape. This process is repeated several times for the purpose of thoroughly cleaning the anterior urethra. The tip of the nozzle is then again introduced into the meatus, the stream is turned on, and is allowed to flow until the compressor urethræ muscle yields and the lotion passes back into the bladder. As soon as the patient expresses a desire to urinate the injection is stopped, and he is instructed to empty his bladder; this process is repeated once or twice.

It is important to avoid injecting so much fluid that the bladder is markedly distended; if this is done, undue reaction will follow the treatment and inflammation of the bladder will be aggravated.

When the patient still suffers from marked tenesmus and has difficulty in fully emptying his bladder, a soft-rubber catheter is employed if this can be introduced. If spasm of the compressor urethræ muscle is so obstinate that it resists the introduction of a soft instrument, the English catheter may be used, its passage being preceded by instillation of a few drops of a 4 per cent. solution of cocaine into the posterior urethra. When the catheter has entered the bladder, as shown by the escape of purulent fluid, from 1 to 3 ounces of the lotion are injected either by the fountain syringe or an ordinary piston syringe. The solution is allowed to escape immediately, but the bladder is not completely emptied. This injection is repeated two or three times, and the catheter is withdrawn whilst the injecting fluid is still flowing through it.

Irrigation or injection into the bladder may be repeated once or twice daily. It is well to employ first normal saline solution at blood heat; if this is followed by undue reaction, the symptoms increasing in severity, and if the surgeon has been careful not to over-distend the bladder in the course of his treatment, irrigations should be dispensed with, unless indications for their use are absolute—*i. e.* ammoniacal and decomposing purulent urine stagnating in the bladder.

If the normal saline is well borne, and particularly if it seems to relieve inflammatory symptoms, one of the mild antiseptics may be substituted for it, preferably permanganate, the strength of the solution being gradually increased in case it does not excite undue reaction. It will often happen that no antiseptic can be employed without increasing inflammation. In this case normal saline solution should be used.

When the urine is clear immediately after having been passed, and on microscopical examination shows no pus, the case can be regarded as cured.

Chronic Cystitis.—The treatment of chronic cystitis will be conducted more successfully if it is borne in mind that septic inflammation of the bladder has no tendency to persist in the absence of favoring causes, such as obstruction to the outflow of urine or vesical stone or tumor or chronic congestion. The first consideration in the treatment of chronic inflammation of the bladder is, then, removal of the cause. This in itself is often curative. Thus, a cystitis originally due to gonorrhea, but which has persisted because of stricture, usually disappears promptly when the narrowing is fully dilated. (This fact does not hold good, however, of chronic posterior urethritis.) Chronic inflammation of the bladder dependent upon stone is promptly cured by removal of the foreign body; a cystitis dependent upon obstruction caused by prostatic enlargement clears up when the obstruction is removed. It often happens, however, that the causes which predispose the bladder to inflammation, and which prevent complete resolution when infection has once taken place, are irremediable. Thus the muscular atrophy following spinal injuries, the obstruction due to inoperable tumors, the infiltration of advanced tuberculosis, will indefinitely prolong an inflammation and are past surgical help. When a chronic inflammation is due to an irremediable cause, or when the cause of such inflammation cannot be discovered (in this case it is usually tubercular), treatment must be directed toward lessening the severity of the cystitis and thus limiting the hurtful effects of chronic inflammation on the bladder-walls.

The therapeutic indications are in general those applicable to acute cystitis, but with some differences of major importance. Thus, chronic cystitis is unbenefited by rest in bed. Powerful antiseptic and stimulant injections are at times highly serviceable, and medicinal treatment by the mouth is markedly beneficial.

The treatment is constitutional and local.

Constitutional Treatment.—Every effort should be made to improve the patient's health. Exercise and diet, so selected that gastro-intestinal disturbances are avoided and constitutional dyscrasiæ are corrected, are directed, and the hours of sleep are properly regulated; the bowels are kept soluble, preferably by enemata of normal saline solution; the skin is properly stimulated by daily cool sponging followed by brisk rubbing; ordinary water or mineral waters are taken freely, preferably hot and an hour before meals; prepared foods, tonics, and even stimulants, are given in accordance with general requirements. The patient is especially cautioned against overfatigue, constipation, prolonged standing, resisting the desire to urinate, long course-dinners, chilling of the surface, dampness or chilling of the feet, or excesses in the way of alcohol.

Some of the natural mineral waters are extremely serviceable, probably not so much because of the solid ingredients as because of the quantity ingested. Of these may be mentioned Londonderry lithia and Poland waters, or, when iron is advantageously associated with the diuretic ingredients of the water, those of the Columbia Springs of Saratoga are useful.

Medicinal treatment should, in the first place, be directed toward improvement of the general health. Thus the uric-acid or oxalic-acid diathesis should receive appropriate medication. Valvular lesion or insufficiency of the heart should be treated, and feeble digestion should be stimulated.

It is well to administer a drug which while not irritating the kidneys may make the urine feebly antiseptic. Salol best answers this purpose, and may be given in doses of 3 to 5 grains three times daily. Every third week salol should be replaced by boric acid, oil of gaultheria, or other urinary antiseptic.

In chronic cystitis the urine is commonly alkaline, and irritating because of this alkalinity: an acid urine is less likely to decompose, and the acid lessens the rapidity of bacterial growth. Hence it is well to administer some form of acid: hydrochloric acid may be given with wine of pepsin after meals, or benzoic acid or benzoate of soda, 10 grains, three times a day.

The balsams have had their chief applications in the treatment of chronic cystitis, particularly that form of inflammation which persists in the vesical neck after the subsidence of an acute gonorrhea. Of these sandalwood oil is most serviceable. It may be given in the form of an emulsion, but better in soluble elastic capsules one hour after a full meal; from 5 to 15 drops may be given three times a day. Oleoresin of copaiba stands next in efficiency. The dose is the same as for sandal, and these two drugs may be advantageously mixed. Fluid extract of pichi is distinctly less powerful, and the same can be said of saw-palmetto. It must be remembered that the good which is accomplished by these drugs is in no way commensurate with the disadvantage incident to disturbing digestion, and that on the first sign of dyspepsia the balsams must be immediately withdrawn. Even though they agree with the stomach, if after they have been given for three days there is no marked improvement of symptoms—*i. e.* lessened frequency of urination, lessened pain, and diminution in the quantity of pus—there is nothing possibly to be gained by their continuance. They seem to act as stimulants to the sluggish circulation of the chronically inflamed mucous membrane.

Of other drugs serviceable for their direct action on the bladder, may be mentioned tincture of cantharides, given in drop doses hourly for two or three days; oil of turpentine, 5 drops in emulsion six times a day; arbutin, 5 grains three times a day; oil of eucalyptus, 10 drops six times a day.

Among other forms of systemic treatment the beneficial effects of change of climate and surroundings and of properly directed hydro-therapeutic treatment can scarcely be exaggerated.

As a means of throwing a certain amount of the burden of elimination upon the skin, the writers have long been in the habit of directing patients, particularly those whose kidneys show signs of giving out, as also those suffering from cystitis without involvement of the higher tract, to use a vapor-box. This can be built in the patient's bath-room. It consists of a box large enough for the patient to sit in with his head projecting from a hole in the top. A door is cut through the side and the top is provided with a hinge. Within the box is placed either a gas stove or an alcohol lamp. The patient sits on a chair, placing a towel around the neck, thus covering the opening through which the head is thrust. The lamp is lit, the door is closed, and the bath is prolonged for from five to fifteen minutes, always to the point of producing a dripping perspiration. This is followed by a cool sponge-bath and vigorous friction with a coarse towel. It seems to exert a markedly beneficial effect upon the more distressing symptoms of chronic cystitis, but it is not adapted to all patients, since certain ones exhibit an idiosyncrasy against surface heat.

The *local treatment* of cystitis consists in irrigations, instillations, and drainage through the urethra or through a perineal or suprapubic opening.

Irrigation is applied to the bladder for exactly the same reason that it is applied to any suppurating surface. It is designed to remove, mechanically, decomposing discharges, to exert a healing and stimulating effect upon inflamed surfaces, and to lessen or prevent further fermentation or decomposition. It cannot possibly disinfect the entire diseased and suppurating tissues, since the micro-organisms are so deeply placed that they cannot be reached or affected by the most powerful antisepties. Solutions are usually chosen for their cleansing rather than for their stimulant effect, since it is difficult so to select a powerful drug that its irritating effects will not do more harm than good. Therefore weak, unirritating antiseptic lotions are usually chosen. Of these the most serviceable are silver nitrate 1 : 5000 to 500, potassium permanganate 1 : 5000 to 2000, carbolic acid 1 : 500, boric acid 1 : 50, normal saline solution .7 per cent.

When a stimulant effect is desired—and this is in cases of chronic indolent cystitis characterized by marked thickening of the bladder-walls and resistance to the milder forms of treatment—silver nitrate is the solution of choice in the strength of 1 : 500 to 1 : 50.

Irrigations may be applied either through the short urethral nozzle or the soft-rubber catheter. The bladder should not be distended to the point of causing pain and spasm. When these result from the injection of one or two ounces, irrigations should give place to instillations.

The treatment should be repeated in accordance with the amount of reaction excited. When the latter is practically wanting, and the suppuration is free and decomposition occurs rapidly, the washings may be repeated twice daily. Usually once daily is sufficient, though when there is retention of foul, ammoniacal urine, requiring for its removal the repeated daily use of the catheter, irrigation should be practised each time that the catheter is passed. The patient is taught to irrigate himself, and usually finds it most convenient to apply the treatment while sitting in the water-closet.

When the short nozzle is used the patient can usually tell when the fluid enters the bladder, and the steady flow of the fluid can be felt by the surgeon's fingers, since it imparts a certain thrill which when once recognized cannot be mistaken. This irrigation is repeated until the fluid injected returns clear of pus. The elevation of the irrigating vessel is from six to eight feet above the level of the bladder. The writers frequently use a narrow, deep glass reservoir with a gauge marked on the side. By watching the liquid in this reservoir it is easy to tell when the fluid is flowing into the bladder and to determine accurately the amount injected. This form of irrigation is applicable when the patient urinates easily and empties his bladder almost completely. When cystitis is complicated by retention of urine, or when the act of urination is extremely painful, irrigation should be accomplished by means of a soft catheter. This is attached to a fountain syringe; the lotion is allowed to flow through, and while it is flowing the catheter is slowly passed into the bladder; three to six ounces are injected, and the tube leading to the fountain syringe is disconnected and the injection is allowed to flow out. The bladder is emptied, is again injected with antiseptic lotion which is allowed to escape, and this process is repeated until the fluid comes away clear. About an ounce is left in the bladder and the catheter is slowly withdrawn, the fluid still flowing through it.

In practising the cleansing irrigations the strongest antiseptic solution should be selected which can be used without causing undue irritation. The latter varies in different cases, and even in the same case varies at different times. The least irritating lotion is normal saline solution; next in point of blandness comes boric acid, next permanganate of potassium.

It often happens, because of sacculation in the bladder, that the removal of all the decomposing uro-purulent secretion is extremely difficult. In such cases it is well to have the patient change position during irrigation, to stand up, to lie down in the dorsal and lateral decubitus, or even to assume the knee-elbow position. Experience will soon show what posture is most favorable for thorough cleansing of the bladder.

The effect of these irrigations should be to diminish the quantity of pus and mucus, to render the urine bland and unirritating, and to lessen the severity of inflammatory phenomena, though these in chronic cases are often entirely wanting.

When irrigations are administered for their stimulant effect, strong antiseptic solutions are used. The purpose of this treatment is not to destroy all the germs lying in the bladder, but to set up an acute cystitis, thus stimulating sluggish circulation, replacing an old and organizing exudate by an acute and inflammatory infiltrate, and putting the bladder-walls in such condition that, after having ridden themselves of a long-standing inflammatory deposit, partial or complete resolution may take place.

The solution of choice is silver nitrate. The injection should be made through a catheter, and should be preceded by a thorough washing with boric-acid solution. The strength of the solution varies from 1 : 500 to 1 : 50. From 1 to 4 ounces of this lotion are thrown into the bladder, and left there one or two minutes and then allowed to escape. The bladder is then washed with boric-acid solution, and this washing is repeated twice daily for the next three or five days. This treatment is not free from danger, since by rendering a chronic cystitis acute it may cause infection of the kidneys by way of the ureters. It should never be employed when cystitis is complicated by retention, but in certain long-standing inflammations, persisting in spite of more conservative treatment, this method may prove serviceable.

Instillations are particularly serviceable, when because of irritability of the bladder and intolerance of distention, irrigations excite undue inflammatory reaction, and when the inflammation is limited in the main or entirely to the neck of the bladder and the vesical trigonum.

The symptoms of cystitis—*i. e.* frequency, urgency, tenesmus, strangury, and pain—are chiefly dependent upon inflammation located about the vesical neck; when these symptoms are particularly well marked, there is reason for believing that inflammation is thus situated.

Instillations are applied by means of an instillator, which is a silver or hard-rubber cylindrical catheter about 18 Fr. caliber, provided with a fine canal; to the end of the shaft of this catheter is fitted a hypodermic syringe with a capacity for forty minims. In applying the instillations the syringe is filled with the lotion of choice; the catheter is lubricated with glycerin or boroglyceride, and is introduced into the urethra until its tip is within the grasp of the compressor urethræ muscle. The piston of the syringe is then driven down, causing the injection to flow along the membranous and prostatic urethra and into the bladder. It is sometimes desirable to employ a more bulky injection, from two drams to half an ounce. In this case a larger syringe should be attached to the catheter.

The solutions of choice for instillation are silver nitrate from 1 to 5 per cent., corrosive mercurial chloride 1 : 6000 to 1 : 2000 iodoform emulsion, and glycerin, 10 per cent.; the corrosive-chloride solution and iodoform emulsion are mainly serviceable in tubercular cases. The silver nitrate is useful in gonorrheal cystitis. It is nearly always followed by marked inflammatory reaction, which subsides in from one to two days, and is followed by a marked amelioration of symptoms.

Vesical drainage is indicated when, in spite of the general and local treatment already outlined, or because this cannot be borne without exciting undue inflammatory reaction, the symptoms of cystitis are steadily progress-ing and the dangers of ascending nephritis are increasing. It is mainly in ribbed and sacculated bladders which cannot be thoroughly cleansed, and in the contracted, irritable bladders of long-standing parenchymatous inflammation, or in those that cannot be properly treated through the urethra, that drainage will be required.

The simplest and safest form of drainage is that by continuous catheterization. A soft catheter of medium caliber should be selected: since it is usually in patients with enlarged prostates that such drainage is required, the Nélaton "elbow" catheter is the one of choice. Important points to observe in the treatment are that the eye of the catheter lies just within the bladder, and that the instrument thoroughly and continually drains this viscus. To determine the position of the eye of the catheter in relation to the neck of the bladder, the instrument is introduced and the bladder is emptied. Four to six ounces of boric-acid solution are then injected, and the catheter is withdrawn until the fluid ceases to flow. It is then passed in until the fluid begins to flow, and is held in this position until the bladder is empty. It is secured by a thread tied around the shaft of the instrument a sixth of an inch beyond the lips of the urinary meatus; the ends of this thread are secured to adhesive straps which are fastened to the sides of the penis. The end of the catheter is plunged into an antiseptic solution contained in a urinal which is kept at a level lower than that of the base of the bladder. The catheter is carefully watched to see that the urine flows continuously. Twice a day the bladder is irrigated through this instrument with a mild antiseptic lotion, and once in forty-eight hours the catheter is changed. If it has been properly placed, it will usually excite little or no pain, but slight urethral inflammatory reaction, and it will promptly relieve the tenesmus and pain from which the patient has been suffering. If it becomes blocked or its end is introduced too far into the bladder, it is worse than useless.

This continuous catheterization may be kept up from one to three weeks. It usually causes a mild traumatic urethritis. This is treated by withdrawing the catheter slightly at each irrigation until its end lies without the compressor urethræ muscle. By forcing an antiseptic solution into the catheter it will then flush out the entire anterior urethra. After thus flushing the entire anterior urethra with a pint of fluid the catheter is again introduced into the bladder.

When the catheter excites so much pain that it cannot be borne, or when it cannot be introduced, the indications are plain for continuous drainage through a perineal or suprapubic opening made into the bladder. If the opening is temporary—*i. e.* if there is reason to believe that cystitis is curable—the perineal opening is the one of choice. This is made by a median perineal cystotomy, as described elsewhere. A drainage-tube the size of the little finger is introduced, and is secured in place by a stitch to the skin, and through this opening the bladder is washed twice daily, the patient being allowed to move about wearing a urinal. The tube devised by Tilden Brown answers admirably for purposes of drainage.

Suprapubic drainage, particularly the method proposed by Hunter McGuire, offers the advantage of not requiring the patient to wear a urinal. The method of performing this is as follows: Preparations are made such as are customary in performing the operation of suprapubic cystotomy. The bladder is thoroughly irrigated with boric acid; a rubber bag is inserted into the rectum and distended with 6 or 8 ounces of water; 4 ounces of boric solution are injected into the bladder. With a small scalpel the incision is made through the skin and superficial fascia in the median line, commencing about two inches above the pubic bone and extending a little below the level of its upper border. The fibers of the recti muscles are separated with the handle of a knife, and the wound is deepened to the transversalis fascia. When this is incised the prevesical fat is exposed. The large veins running through it are pushed aside, and the friable tissue is scraped through until the finger rests upon the wall of the bladder. The back of the knife is then placed closely against the upper border of the pubis; its point is pushed through the wall of the bladder and a cut is made upward about half an inch long.

Before all the fluid escapes a finger is introduced through the opening and the interior of the viscus is examined. The rectal bag is then removed; a rubber catheter is introduced along the finger into the bladder, and is stitched to the skin at the margin of the wound. There is practically no loss of blood, since the incision is made through tissues which contain no large vessels.

The wound is dressed by laying some gauze around the catheter, the patient is put to bed, and the free end of the catheter is inserted into the neck of a bottle to catch the urine. No stitches are employed nor is any effort made to approximate the surfaces of the cut. The wound heals by granulations, and in two weeks only a fistulous tract is left in the line occupied by the catheter.

The patient is kept in bed for two or three weeks until the wound heals. The urine is kept acid; the bowels are opened by regulation of the diet and the use of simple laxatives. At the end of two or three weeks there remains an artificial urethra lined with a coating closely resembling mucous membrane.

The patient is then fitted with a silver plug or stopper. This plug should have a diameter of about No. 20 Fr., and should be just long enough to enter the bladder. It keeps the opening patent and acts as a stopper to prevent dribbling of urine. It should be constantly worn, except when the patient wishes to empty his bladder or to irrigate it. The plug is kept in place by a belt which goes around the hips and passes over the plate of the plug. This belt is prevented from slipping up or down by a belt above, which is supported by the hips and by perineal bands which encircle the thighs. Through this short direct artificial urethra irrigations are readily accomplished. The operation is especially applicable to cystitis complicating enlarged prostate.

TUBERCULOSIS OF THE BLADDER.

Tuberculosis of the bladder is a not uncommon condition. There are two main classes of vesical tuberculosis: those of one class are a part of the systemic metastasis of pulmonic, osseous, or intestinal tuberculosis; those of the second class constitute uro-genital tuberculosis. Etiologically, no such division can be maintained, for perhaps the majority of cases of uro-genital tuberculosis are secondary to foci elsewhere in the body, either demonstrable or hidden. From the standpoint of practical surgery, however, the division is justifiable and advantageous.

The relations of the bladder to uro-genital tuberculosis are threefold: Either the bladder infection may be secondary to renal tuberculosis, or the primary focus may be in the bladder, or the vesical infection may be secondary to foci in the lower uro-genital tissues. That the first and third varieties are the common forms is in itself evidenced by the rarity of vesical tuberculosis in the female, which is well expressed by the figures of the pathological department of the Dresdener Krankenhaus, where in 2500 necropsies on female bodies vesical tuberculosis was 4 times noted.

Concerning the relations of vesical to renal tuberculosis there has been much divergence of opinion. It is not always possible, even with the greatest care, to ascertain in the individual case whether it belongs to the ascending or to the descending form. Clinically, symptoms are liable to appear earlier after vesical than after renal involvement, so that, even though the renal lesions be the earlier, the first symptoms might be referred to the bladder. On the other hand, the extent of the lesions post-mortem may be misleading, since the progress of tuberculosis is usually more rapid and extensive in the kidney than in the bladder. Nor does the involvement of the prostate, seminal vesicles, epididymis, or testicle always furnish conclusive evidence, since their infection may be secondary to the vesical lesions.

Hamill has carefully studied the well-recorded cases of renal tuberculosis in children (55 cases in all, with 1 new case of his own), and in only 1 of these cases was there any genital involvement; this was regarded as secondary by the author of the report. In 1 other case the primary infection might have been in the bladder, but any conclusion was doubtful. In 16 cases the bladder was involved, in 4 cases extensively. It is therefore certain that in children the primary lesion of uro-genital tuberculosis is nearly always in the kidney.

In the adult the relations are very complex, and the views correspondingly divergent. Nearly all writers concede an ascending and a descending form of infection of the bladder; the relative frequency, however, is entirely unsettled. Camargo has published the records of the cases which came to autopsy in Geneva, and of the 30 cases of renal tuberculosis, 26 showed involvement of the bladder, while the genitalia were involved in only 11: conceding, what could not be reasonably assumed, that the 11 cases in which the genitalia were involved were of the ascending type, the decided majority would still lie with the cases of descending type. In striking contrast to the figures of Camargo are those of Simon, who in 14 cases found tuberculosis of the seminal vesicles 13 times, of the prostate 13 times, of the epididymis 12 times, and of the kidneys 9 times; but he did not show that the 9 cases in which the kidneys were affected could not have been of the descending type.

The experimental attempts at a solution of the question by injections of tubercle bacilli into a ligated ureter above the ligation have given discordant views: only once (Albarran) has renal tuberculosis followed the experiment. Although the matter is of considerable importance, it is obvious that more pathological data than are available to-day must be at hand before a definite statistical conclusion can be formed. It is nevertheless our present opinion that the bladder is more often infected by tuberculosis from the kidneys than from the genitalia. It is quite certain that in not a few cases there is a simultaneous infection of various parts of the uro-genital system.

The method of infection of the bladder obviously varies. Secondary to renal lesions the vesical mucosa may be infected from the urine, or the process may travel down the ureter, and from there attack the bladder: a hematogenetic or lymphatic infection is rare, but such cases have occurred.

Infection from the genital system probably occurs always by contiguity. The process extends from the epididymis or vas deferens or the seminal vesicles to the prostate, whence it extends to the region of the canaliculus seminalis, and from here directly to the bladder, following which it extends by natural contiguity to the ureters. The process is the same in the primary infection of the prostate gland. Whether the semen can infect different tissues in the same individual has not been decided. It is not probable that infection of the bladder from the genitalia by the blood-vessels or lymph-channels occurs. Ascending infection from the urethra has never been demonstrated.

In primary vesical tuberculosis the site of the lesion may be anywhere. Whether ascending or descending, in secondary infection the area commonly affected is the base, the neck, and around the mouths of the ureters, whence the process may extend laterally. The first stage consists in infiltration of the mucosa and submucosa. Often the appearance is that of typical miliary tuberculosis—tiny scattered clumps of round-cells, with a few giant-cells and the easily demonstrable bacilli. In other cases the growth is massive, and has not the tubercular appearance, being more of a uniform submucous infiltration. It is probable that in all cases both these stages are traversed. Sooner or later caseous degeneration and necrosis occur, the mucous membrane sloughs away, and the typical tubercular ulceration is produced. In some cases the ulcers are tiny, numerous, and very shallow. In other cases the ulceration is extensive, irregularly deep, and in places excavating. Perforation is extremely rare; the process is so slow that the adventitia has ample time to protect itself by fibrous overgrowth.

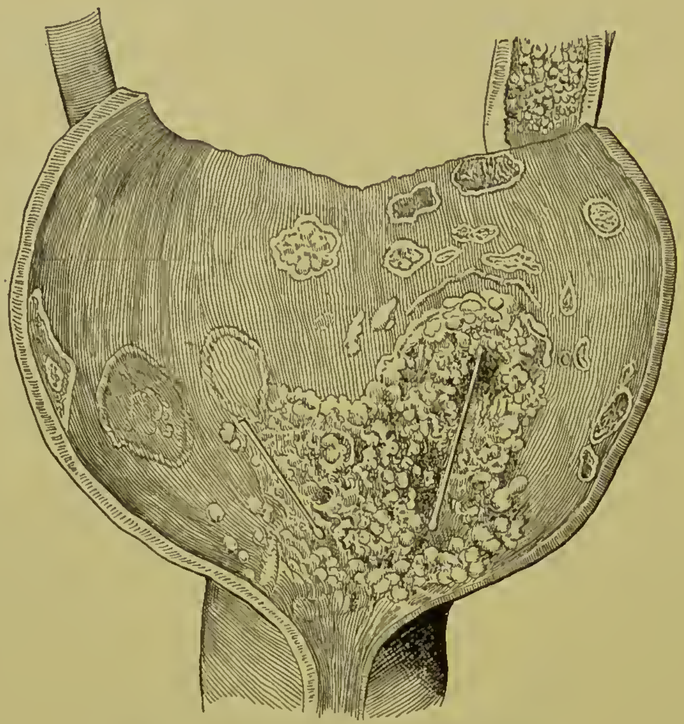


FIG. 111.—Tuberculosis of the bladder (Orth).

The base of the ulcer is formed of round-celled infiltration; the edges are composed of the same tissue which extends for some distance beyond the edge of ulceration. Beside the ulcer is a more or less marked inflammation of the mucous membrane, usually septic in character. The mucous membrane may present tiny villosities, and may be covered with urinary salts and blood-pigment, with which the ulceration may likewise be encrusted. Calculus may coexist, and is obviously a secondary condition.

When the vesical infection is simply a part of a general acute miliary tuberculosis, the process rarely advances to the point of ulceration. There is but little local reaction, the deposits are usually submucous, and cystitis is usually not present.

Vesical tuberculosis is usually seen between the ages of fifteen and thirty-five years. Cases in younger subjects are not infrequent; in older subjects the infiltration is rare. The vast majority of cases occur in males. In recent years tuberculosis of the Fallopian tubes and ovaries has been shown to be comparatively common, and in some of these cases the bladder has been involved, probably by paravesical extension. These cases, however, have not usually presented vesical symptoms. As vesical infection in women, apart from the problematical infection during coitus, must be either from the kidneys, tubes, and ovaries or primary in the bladder, it is obvious that, since vesical tuberculosis is rare, renal tuberculosis likewise must be rare; and this agrees entirely with pathological statistics. Just why renal tuberculosis should be so much rarer in women than in men cannot be explained. The advocates of the ascending form of infection find in this fact a confirmation of their view that the primary focus of uro-genital tuberculosis is in the testicle, epididymis, prostate, etc. As before stated, however, the pathological conditions are so complex and obscure that the matter cannot be settled in such an easy, offhand manner.

The conditions occur most often in families with tuberculous tendencies.

Symptoms.—The first symptom of vesical tuberculosis is pain, hematuria, or increased frequency of micturition. Usually pain and increased frequency of micturition are combined, and they are commonly the initial symptoms. The increased frequency of micturition is usually noticed during the day; in some cases it is not present during the night. Later in the course of the case it usually becomes aggravated, and after the voiding of urine there is not the sense of complete evacuation, but a constant desire to expel an imaginary residue. The symptom is in some cases not constant, but intermittent, and the patient may be free from it for weeks at a time.

The pain is at first only experienced during the act of micturition. It is a stinging, burning urethral pain, which may be felt in the deep urethra, but is more commonly referred to the anterior urethra, and often persists in the glans after micturition: should the urethra or the neck of the bladder be blocked by a clot of blood or by a mass of tenacious pus, the pains will at once become colicky in character. Later in the case penile pains are felt apart from the act of micturition.

A dull suprapubic pain develops in nearly all cases; it is increased by vesical distention, and decreased or entirely relieved by the evacuation of urine. In some cases there is a deep pain behind the scrotum, sometimes accompanied by a bearing-down which is usually interpreted to be the result of prostatic lesions. If the disease be secondary to subvesical genital lesions, the pains characteristic of such conditions would coexist with the vesical pains, which indeed they often precede. In similar manner renal and ureteral lesions would cause the pains proper to those conditions, but it must be remembered that even though the supravesical lesions were the earlier, their symptoms would very often not have preceded the vesical pains.

The hematuria is often very variable. Usually there is but little blood, and often this is seen only toward the close of the urination. It may, however, appear with the beginning of the stream and may color the whole flow. The bleeding is likely to be constant, but may intermit, and long periods may pass without any bleeding. The quantity is usually slight, but may be very profuse, and rarely large clots may form in the bladder. As a rule, the bleeding is spontaneous, but there can be no doubt that a strain or exposure to cold or wet can excite it.

As a rule, early in the case the stream of urine is not affected. Stoppage of the stream may, however, occur, and is either due to reflex spasm or is volitional (though scarcely conscious) stoppage. Later the urethra may be momentarily obstructed by blood, pus, or tissue, and a more or less complete stoppage of the stream will ensue.

Vesical tuberculosis is often compatible with moderate general health. Extensive renal lesions and severe cystitis, however, soon profoundly affect the patients. In all cases they gradually become emaciated, weak, and anemic. Later the anemia assumes a cachectic character, the general asthenia becomes marked, and the subjects fall into a wretched condition, frequently aggravated by systemic tuberculosis.

Fever is often present. It may be due to the vesical tuberculosis (including in this the uro-genital), to systemic tuberculosis, or to septic cystitis. It is usually moderate, with an evening rise; it may be accompanied by slight chills and by perspiration. In rare cases severe septic cystitis may cause high fever, with profound systemic intoxication.

The symptoms of acute or chronic uremia often alter the appearance of these cases, and obviously a systemic or other local tuberculosis would alter the symptomatology in various ways.

Urinary Signs.—Early in the case the urine is normal in quantity and acid in reaction. A rare reflex polyuria has been noted. Later, the renal lesions may produce the polyuria of interstitial nephritis, but oliguria is the usual condition. The advent of cystitis will be followed by a change in reaction to alkalinity.

The specific gravity is normal at first; later it is usually lowered. So long as the urine remains acid it will be fairly clear, although slightly opaque on account of the presence of pus: when it has turned alkaline it becomes very densely clouded. The color is whitish when no blood is present; according to the extent of bleeding it will vary from the faintest pink to a deep dark-red.

It is rare that macroscopic clots occur. Under spectroscopic examination, while the urine remains acid the absorption-bands are usually those of oxyhemoglobin; when the urine is alkaline the absorption-bands of methemoglobin are more commonly seen.

Albumin is of course always present with pus or blood; it requires, however, a large amount of pus or blood to produce a marked reaction of albumin. In cases with renal involvement the albuminuria would be more marked, and in any given case it may be necessary to determine its vesical or renal origin by the methods given on pages 356 and 401. In this relation it must be borne in mind that amyloid disease is not uncommon, and that Senator's sign (excess of globulinuria) will be present in such cases.

The sediment varies greatly. In some cases it is slight; in others it is excessive. Pus is always present from the beginning. The pus-cells are the ordinary polymorphous leukocytes, often deeply degenerated. In alkaline urine they may become agglutinated and lose almost entirely their morphological characteristics. The blood-cells are usually well preserved in acid urine; in alkaline urine fragmentation is common. Microscopic clots are not uncommon. The crystalline sediment in acid urine is usually composed of urates, uric acid, and rarely oxalates. When the urine has become alkaline the triple phosphates are precipitated in large quantity.

Pieces of tissue are rarely voided in tubercular cystitis, and when voided are usually so degenerated as to preclude any hope of a histological diagnosis. From them, however, the possibility of a neoplasm may sometimes be excluded. Leyden has called especial attention to gritty particles in the urine of these cases.

Tubercle bacilli are sparsely contained in the pus. In staining for them the older long method (Koch-Ehrlich) is undoubtedly superior to the Gabbet method. Another good method is that of Günther. When in a suspicious case no bacilli can be found, the sediment should be injected into the subcutaneous tissues of the abdomen of a guinea-pig, and the animal killed four weeks later: tuberculosis when present will be seen in the minute lymph-glands or throughout the entire body, and from the infected tissue the conditions may be confirmed by culture studies.

All urine examined should be perfectly fresh, since the smegma bacillus develops rapidly in standing urine. For the differentiation of the smegma bacillus from the tubercle bacillus no positive staining method is known. There is, however, evidence that the tubercle bacilli resist decoloration by alcohol longer than the smegma bacilli, and that they appear more clumped. In doubtful cases an injection-experiment should be made upon a guinea-pig.

When cystitis is present various micrococci, staphylococci, members of the common colon group, and the proteus of Hauser may be found in the urine.

Vesical tuberculosis in the absence of cystitis may reach a comparatively advanced stage, at least in so far as the dissemination of the lesions is concerned, without exciting a single symptom sufficiently pronounced to attract the patient's attention. Careful investigation into the history of these cases will, however, show that there has been some slight frequency of urination, particularly marked during the night and after meals. Often the first warning the patient has as to the abnormal condition is the finding of blood in his urine by the medical examiner. Hematuria may be an early symptom; bleeding is slight, occurs without obvious cause, and is often terminal, one or two drops escaping with the last urine passed. Bleeding is irregularly recurrent, appearing and disappearing suddenly, but as the disease progresses it becomes more pronounced and constant. Very exceptionally, from erosion of a comparatively large vessel, there may be profuse hemorrhage. This is, however, much more characteristic of vesical tumor, and when it occurs should always give rise to suspicion of bladder-neoplasm. Patients usually pass a large quantity of clear urine.

Children often suffer from nocturnal incontinence. Pain is a symptom of cystitis rather than of tuberculosis. This complication (cystitis) almost inevitably occurs in every case of tuberculous bladder. Its exciting cause is usually instrumentation undertaken for the detection of a vesical calculus, the symptoms of which are often closely simulated by vesical tuberculosis. Infection may, however, occur in the absence of all urethral exploration. Having once developed, it is little influenced by treatment, and its symptoms completely overshadow those of tubercular infiltration. Pain is often extremely severe. There is often a torturing desire to urinate, recurring every few minutes, and accompanied by violent tenesmus each time an effort is made to empty the bladder. The symptoms are especially pronounced when the tubercular infiltration attacks the trigonum as the seat of preference; when the trigonum is spared, pain may be entirely wanting or be quite bearable through the entire course of the disease. In the late stages of the disease there may be incontinence of urine from tubercular infiltration of the sphincters.

Diagnosis.—This is based on the discovery of the tubercle bacilli, frequent urination, and hematuria occurring in a young man without appreciable cause, the presence of tubercular lesions in the epididymis, cord, prostate, or seminal vesicles or other portions of the body, and the absence of causes other than tuberculosis which can satisfactorily account for the symptoms.

When tubercle bacilli cannot be found, diagnosis may be made by cystoscopic examination. The finding of disseminated or grouped tubercles or of ragged, irregular, punched-out, necrotic ulcers will be conclusive. It is probably true that no lesion of the bladder requires for its cystoscopic detection and diagnosis more experience than tuberculosis. Hence, when the appearance is not typical and the examiner is not especially skilled, even the findings of the cystoscope may be inconclusive.

König states that one-half the patients who complain of pus and mucus in the urine as the principal symptoms are tuberculous. It is undoubtedly true that many cases of tubercular cystitis are not diagnosed as such, and the surgeon should always suspect tuberculosis when patients present themselves suffering from intractable cystitis, which careful examination and study of the history of the case show is not due to any other of the ordinary causes of this affection.

Prognosis.—Vesical tuberculosis as an isolated lesion is extremely rare; even in the absence of signs or symptoms of involvement of any other portion of the genito-urinary tract the ultimate prognosis is grave; it is made still more serious by the onset of cystitis. The disease may run an extremely slow course, lasting for many years, provided the bladder does not become infected. Under change of climate and the best hygienic surroundings it may become quiescent. It has, however, a tendency slowly to extend.

Treatment.—If vesical tuberculosis is recognized before the onset of cystitis, careful avoidance of the ordinary causes of vesical congestion, such as resisting the desire to urinate, chilling, over-fatigue, and irritating conditions of the urine, the administration of mild antiseptics, such as salol and boric acid, in small doses, due attention to diet and general hygiene, and an open-air life in a dry healthy climate, represent all that should be done besides the administration of preparations such as digested cod-liver oil, iron, nux, and other tonics. It is particularly at this stage of the disease that the passage of instruments into the bladder should be avoided.

It has been shown that it is practically impossible to render the anterior urethra entirely sterile; hence when the instrument is introduced into the bladder through the urethra, it is possible that infection may be carried back in spite of the most minute precautions. The tubercular bladder is predisposed to infection, owing to the chronic congestion or even ulceration caused by the tubercular lesions; infection, once started, is practically incurable, and transforms a painless, slow disease to one which may cause agony and may extend with great rapidity. It is therefore apparent that unless the surgeon is prepared to operate immediately in case conditions are favorable, instruments should not be introduced into the non-infected bladder. This objection does not hold against the introduction of the cystoscope or the sound after cystitis has developed, though the intravesical employment of these instruments undoubtedly aggravates the inflammation.

The local treatment of vesical tuberculosis must be conducted with great care, since violent inflammatory reaction is readily excited. The most successful treatment yet reported is that of instillations of corrosive mercuric chloride as practised by Guyon, who begins with solutions of 1 : 5000, gradually increasing the strength up to 1 : 1000. Even these weak injections invariably excite some inflammatory reaction: this is usually slight and transitory, but may exceptionally be severe.

Before making the instillation the bladder should be entirely emptied. This may require the use of a catheter. In that case it is unnecessary to use two instruments, the lotion of choice being injected through the catheter after the bladder has been emptied and gently irrigated. In practising this preliminary irrigation, always indicated when the bladder contains residual ammoniacal urine loaded with mucus and pus, care should be taken not to produce undue tension, since this is always followed by inflammatory reaction. Two to four ounces of an irrigating solution should be injected at once and allowed to escape, this process being repeated until the liquid flows out clear. The catheter is then withdrawn until its eye lies just within the grip of the compressor urethræ muscle; from 20 drops to 2 drams of the corrosive-chloride solution are driven through it by means of a syringe, after which it is withdrawn.

When the preliminary irrigation of the bladder is not indicated—that is, when the patient is able voluntarily and completely to empty this viscus—the instillator is employed. It is introduced until its tip is just within the grasp of the compressor urethræ muscle, and the lotion is then driven in. The quantity and strength of the lotion introduced are increased carefully, the surgeon being guided by the degree of pain and reaction which is excited. If the tip of the instillator is properly placed, the entire prostatic urethra is moistened by the solution. Treatment is repeated daily or every second or third day, and in a number of reported cases has apparently been followed by definite permanent cure.

Instillations of a 10 per cent. mixture of iodoform in glycerin have been suggested, and, if reports are to be trusted, have given satisfactory results. Of this method of treatment the authors have no personal knowledge; theoretically, it should be serviceable, since iodoform seems to exert a specific effect upon tubercular lesions—not, however, unless it is driven into the substance of the tuberculous infiltration.

Operation is indicated when vesical lavage and instillations have failed to influence the disease beneficially, or when the pain becomes exhausting and is not influenced by safe doses of narcotics. These cases very commonly exhibit an extensive infiltration of the seminal vesicles and perivesical tissues; hence complete eradication of the disease is scarcely practicable. The operation is then performed for the relief of the frequency and urgency of the micturition and pain, the bladder being drained through a suprapubic opening. As the result of drainage the patient may be completely and permanently relieved of his suffering, though it sometimes happens that pain and straining persist.

A perineal opening is in the great majority of cases distinctly to be condemned in these cases. The tubercular infiltration is usually at the bladder-base, about the trigonum and the vesical neck; an incision through the tubercular tissues is likely to be followed by infiltration of the entire wound, resulting in the formation of obstinate, often incurable, fistula. A special advantage offered by the suprapubic operation is that it renders the tubercular lesions accessible to operation, provided these are so limited in depth and extent that it is possible completely to eradicate them. They may be thoroughly curetted and treated with iodoform, which is well rubbed in, or may be destroyed by the application of the galvano-cautery or the Paquelin cautery. According to reported cases, this method of treatment has been followed by some permanent cures. With tuberculosis, even in a reasonable percentage of cases confined to the bladder alone, this form of surgical intervention is one which should be followed by cure in the majority of cases.

The bladder having been opened above the pubis, and the tubercular lesion having been scraped and cauterized, Guyon's double drainage-tube is introduced, the bladder is irrigated four times a day with normal saline solution or a weak antiseptic, and the patient is allowed to recover with a suprapubic opening, which is not allowed to close until cystitis and all painful symptoms have disappeared and no more blood is passed in the urine.

Even with a suprapubic opening there is a constant risk that the wound may exhibit tubercular infiltration, and may re-ulcerate and break down, thus forming a fistula, or that, the ulceration extending still farther, an abdominal hernia may result.

TUMORS OF THE BLADDER.

Pathology.—The pathology of the neoplasms of the bladder has been carefully studied by Virchow, Thompson, Guyon, Cahan, Le Dentu, Hasenklever, Rauschenbusch, Winckel, Sperling, Küster, Antal, Stein, Albarran, and Clado. Of these, Küster, Antal, Albarran, and Clado have written special treatises, which are not only superb contributions to the literature of pathology, but are, furthermore, works which deal in a most superior manner with the practical surgical problems connected with vesical tumors.

Neoplasms may be either primary or secondary: only the primary growths are of real practical interest, and it is these which are considered in the following pages.

Vesical neoplasm is an uncommon condition. Hasenklever collected the statistics of 7037 necropsies, and found cancer of the bladder noted in but 40; of these, 3 only were primary. Cancer is the second of the vesical tumors in frequency, and from the proportion (3 cases in 7000) a good idea is obtained of the frequency of primary vesical growths in general. Clinically, the primary growths are probably more often observed than are the secondary. In any attempt at classification vesical neoplasms must be considered from two points of view—the histological structure and the site of origin.

The direction of growth of any neoplasm is of great practical importance, and this will be discussed under each heading; but we do not think Guyon's classification into implanted, pediculated, and infiltrated tumors possesses more than clinical value, nor can a division into benign and malignant growths be supported: so many tumors are at the border-line that it seems better to consider these qualities while describing each variety of growth.

Not infrequently, the tumors are mixed—that is, composed of different types of tissue—a condition which often influences the clinical course of such growths.

As the largest general class of vesical neoplasms will be studied—

A. **Tumors of Epithelial Tissue.**—Of these there are many varieties, which will be considered seriatim.

Papilloma.—Papilloma is the most frequent neoplasm of the bladder. It is seen most often between the ages of thirty and fifty. It has, however, developed in a child of one year and in an old man of over seventy years. Males are more frequently affected than females. Although Stein in his table found the sexes equally affected, the statistics of all other surgeons who have given special attention to the matter show that about 70 per cent. of papillomata occur in the male sex. The majority of cases in women, however, occur at an earlier period of life than in men.

Site.—The base of the bladder is the favorite seat of papillomata. The vulnerability of the trigonum has been the subject of animated discussion. From the review of a large number of recorded cases it may be concluded that the trigonum is infrequently affected alone. It is, however, often involved with the base or the ureters. The papillomata of the base often extend to the posterior or either lateral wall. Such tumors, limited to the posterior wall, are, however, not uncommon. Somewhat rarer are growths upon the lateral wall, the vault, or the anterior wall. Papillomata usually spring from about the ureteral orifices, rarely from the neck or the opening of the urethra.

In a few cases the tumor has involved almost the entire surface of the bladder; it is single in about 60 per cent. of the cases. Even whenever multiple, it is unusual for the number to exceed three or four, although more have been observed.

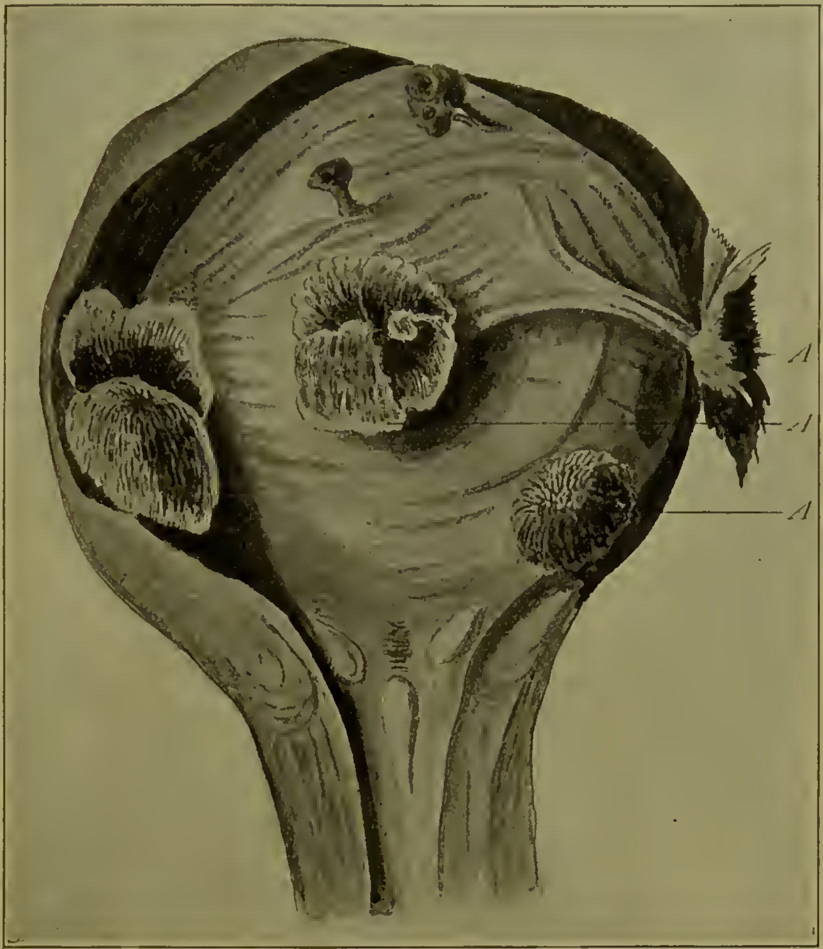


FIG. 112.—Papilloma, the vesical walls thickened by the interstitial sclerotic cystitis: *A*, *A*, *A*, epitheliomatous tumors attached to the vesical walls by long pedicles (Clado).

The macroscopic appearances of different papillomata vary greatly; they are in their very nature exogenous formations. Although the different growths are of different appearances, certain general types may be fixed. Some are simple villosities, small tender tufts which project into the cavity; as a rule, they are short, are quite prone to be multiple, and are very fragile and tender; they may grow into the ureter or urethra. Their color is a reddish-gray, with here and there an occasional hemorrhagic spot. Such growths must be distinguished from the mucous polyps of inflammatory origin.

Another type, the one most frequently encountered, is that in which the growth is pediculated; it is probably formed out of simple villosities, the growth of the pedicle being in some way associated with the varying physical states and movements of the bladder. The tumor presents the appearance of a bunch of villi surmounting a pedicle. This pedicle may be round or flat; it is rarely over one-third to three-fourths of an inch long, although pedicles several inches long have been seen. In a few rare cases there have been several pedicles. The pedicle is attached to the mucous membrane only; when it is pulled the mucous membrane follows in the direction of traction, and there is no induration nor infiltration of the submucous tissue—a point of extreme importance in considering the character of the tumor.

Generally, the size of such papillomata is that of a cherry, but in exceptional cases they have been seen as large as an orange. The surface presents the same appearance as the simple villosities, except that, since they are more liable to hemorrhage, the signs of it are more marked. Pediculated tumors are more often multiple than single. One will usually be large, with one or two smaller growths beside its base.

Another type is the sessile growth. This is distinguished from the simple villosities by its volume; it has a broad base instead of a pedicle, and thus presents the appearance of an elevation surmounted by fine, delicate villi. This form is usually single, but may cover a wide area.

Another rare variety is the coronoid type. This appears as ridges or crests, presenting quite a regular cockscomb appearance; the ridges are very vascular and their color is reddish. In any form of papilloma there may be ulcerations upon the surface or indeed deep areas of necrosis, while as a result of alkaline fermentation of the urine the villi of the tumor may be incrusted with the precipitated urinary salts. Vesical calculus rarely accompanies a papilloma.

Microscopic Appearance of Papillomata.—There are three general kinds of tissue in a papilloma—the stroma, the blood-vessels, and the epithelium. The central portion of a simple villosity is composed of connective tissue; in some instances this is massive, in others almost unnoticeable. This tissue is usually fully-developed connective tissue, but in some cases it contains cells resembling embryonal connective-tissue cells. Elastic fibers are present in variable number. A few muscular fibers may be contained in the mass of connective tissue—muscle-cells which spring not from the vessel-walls, but from the submucosa. The connective tissue may be normally arranged or may be reticulated in a most bizarre manner. In the coronoid form the connective tissue is usually arranged in regular layers up to the summit. (See Plate 4, Fig. 1.)

In the pedicle the connective tissue is usually more abundantly mixed with elastic and muscular fibers than in the sessile forms; the quantity is obviously much less. Round-cells of inflammatory origin may be found in the connective tissue of any type of papilloma, but below the mucous membrane no tissue-alterations can be found. Virchow laid great stress upon the connective tissue as the origin of these growths (*fibrome papillaire*). According to him, a submucous fibroma is the starting-point of the growth. This grows toward the cavity of the bladder, pushes out the epithelium, the vascular tissue hypertrophies according to the needs of the growth, and in this manner the fully-formed papilloma is produced.

The vascular tissue consists of capillaries with scarcely more than endothelial walls. Whether these vessels are formed by simply hypertrophy of the capillaries of the mucous membrane or are evolved from them by a process of lateral budding is not clear. The terminal capillaries end just beneath the epithelial covering in tiny loops, being separated from the epithelium by a thin layer of homogeneous-appearing material which has been erroneously described as a membrane. In rare instance the capillary tissue assumes a true cavernous hypertrophy. In nearly all sections small areas of hemorrhage can be seen just outside the capillary wall.

Billroth—and following him Klebs and Rindfleisch—believed that the first steps in the formation of a papilloma was the formation of vascular loops from the capillaries of the mucosa, which later became surrounded by connective tissue and pushed out into the cavity of the bladder. Muron has expanded the idea, and compares papillomata to placental villosities, while Hicks has in addition insisted upon the active rôle of the vaso-formative cells.

The covering of the papilloma is composed of epithelium. The cells are cylindrical in shape, more or less regularly placed in parallel rows, several strata being superimposed upon each other. The most superficial cells are often flat, but the appearance is never quite that of the normal vesical epithelium. The nuclei are quite small, and located toward the base; the protoplasm is granular.

A rare form has been described by Albarran in which the cells are flat, polygonal, or even spindle-shaped, and arranged in layers like a pavement (*type de revêtement à cellules claires*). The same author has also described an atavistic form in which the tissue was of the allantoid type.

Clado believes that the epithelium is the tissue at fault in the formation of these growths. He contends that they develop by overgrowth of the normal papillæ of the vesical mucous membrane, which are most abundant at the base. He admits, however, the further possibility of their being developed by irritation of the epithelium entirely independent of the papillæ. He thus considers them as entirely analogous to cutaneous papillomata. It seems to the author, without insisting upon his views as to the consecutive steps in the process, that in these neoplasms the primary overgrowth is in the epithelium.

One further point must be insisted upon: below and to the sides of the site of the papilloma the tissue is entirely normal. Any extension or infiltration converts the growth into one of different type, with malignant tendencies. It is, however, undoubted that in rare cases true papillomata become carcinomatous. Beyond this type there is no mixed form of vesical tumor in which the papilloma is concerned. The only lesions consecutive to papilloma are mechanical.

Adenomata.—True adenomata of the bladder are very rare. They are situated near the neck of the viscus, may be pediculated or sessile, and in the latter event are encapsulated. The growths have always been single. The pedicle or base is composed entirely of the connective tissue of the submucosa; there is no infiltration of the adjacent tissue; the growths can be easily shelled out with the finger. They are very vascular.

The surface of the growth may be covered with villosities, which have, however, no connection with the tissue proper of the tumor. This consists of regular acini of cylindrical epithelial cells, the basement membrane is well defined, the lumen of the canals may be very large and filled with homogeneous substance or with bodies which resemble the prostatic concretions. Klebs, who described the first case, looked upon the glandular tissue as of prostatic origin, but careful study of later cases has shown that they have no relation to the prostate, and that they are, in fact, true adenomata whose type is the submucous glands. The canals may be so dilated as to form small cysts in the substance of the growth. Although rare, such tumors, on account of their site, are clinically important.

Albarran's case presented symptoms which suggested vesical tuberculosis. The true adenoma is entirely exogenous: any infiltration would indicate a carcinomatous process.

Carcinomata.—The carcinomata of the bladder vary greatly in appearance. Some are exogenous formations which have a marked resemblance either to papillomata or adenomata; they are, however, also always endogenous. Others are purely endogenous, and the mucous membrane may not be affected at all.

Primary cancer of the bladder is not only very rare, but is quite rare in comparison with secondary vesical cancer.

Out of 40 cases of vesical cancer reported in over 7000 necropsies collected by Hasenclever, only 3 were primary, and only 14 cases were found in the records of the Pathological Institute in Munich (Zansch). Males are more frequently affected than females, in the proportion of nearly 3 to 1: of 137 cases collected by Clado, 99 were in males. The age affected is usually between forty and fifty-five, although malignant disease has been seen in the infantile bladder.

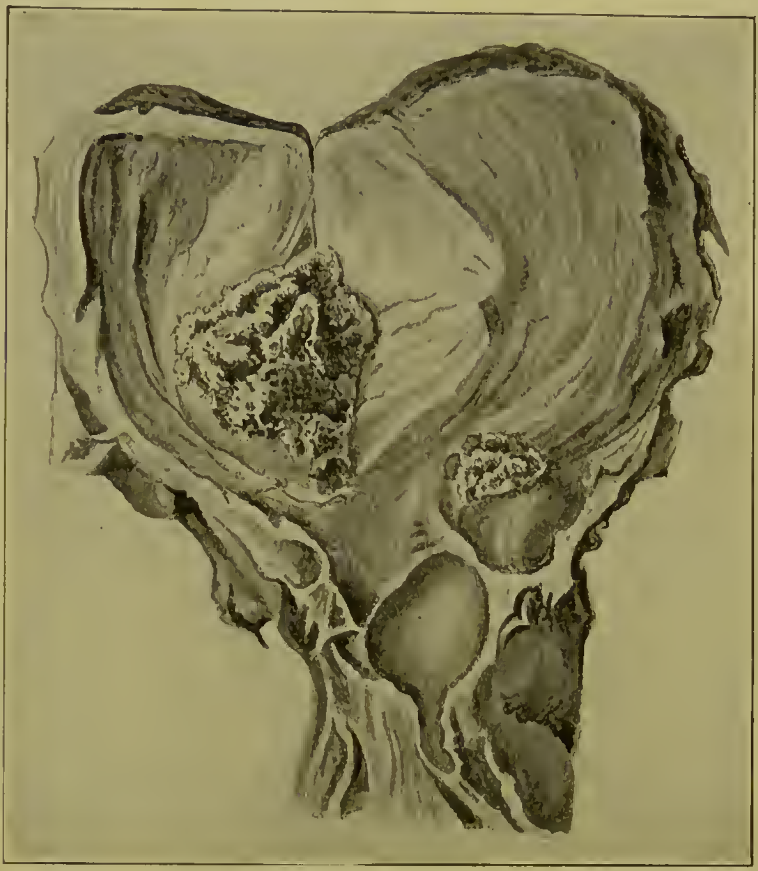


FIG. 113.—Adenoma of the bladder (Clado).

It has been customary to divide the malignant epithelial growths of the bladder into epitheliomata and carcinomata, with the further addition by some authors of adeno-carcinomata. We do not believe such divisions to be pathologically necessary or clinically advantageous. All such growths are, in the strict pathological sense, carcinomata. As above stated, however, they differ widely in gross and microscopic appearances, so that for purposes of description it is convenient to divide them into several forms.

The first form is one which is closely allied in many respects to the adenoma—the adeno-carcinoma or cylindrical epithelioma. This is a rare tumor. Like the adenoma, it was originally classed by Klebs as of prostatic origin, but this has been disproved by its occurrence in the female bladder (Kaltenbach), and by the histological demonstration that it springs from the deep glands of the mucous membrane and has no connections with the prostate, which has, furthermore, in several cases, been shown to have been normal.

It is most often a pediculated growth, but may be inserted with a broad base. The surface is lobulated and covered with fine villi; the general aspect is often quite like the papilloma. It is not often found ulcerated.

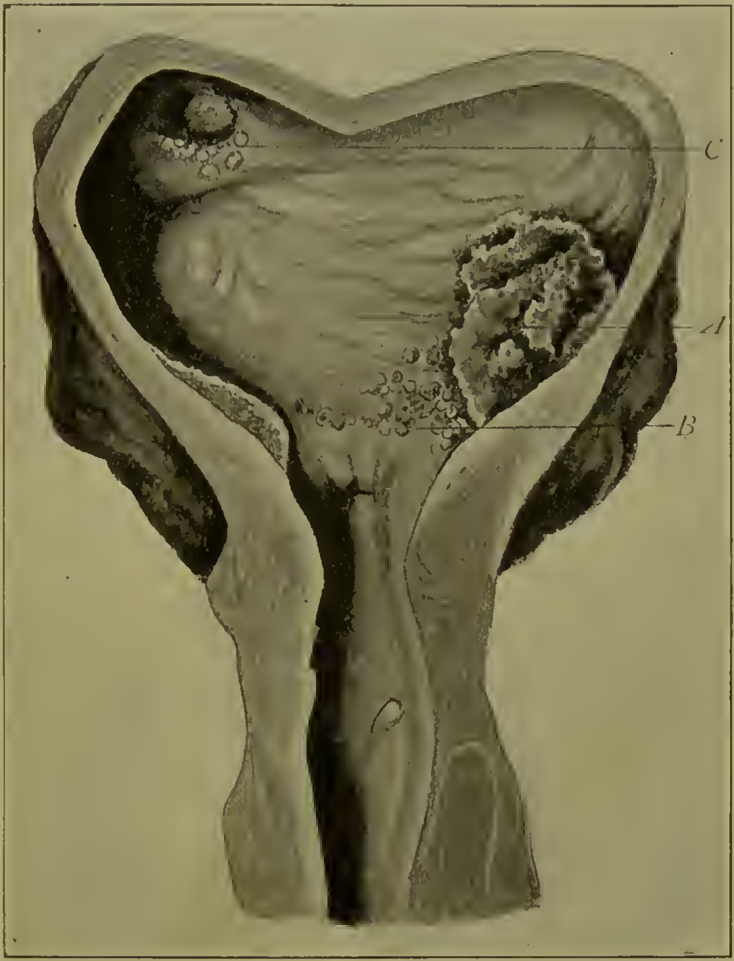


FIG. 114.—*A*, epitheliomatous tumor; *B*, wart-like growths; *C*, villous growths around a vesical cell (Clado).

When the site of implantation is examined, it is noted to be indurated and infiltrated; the mucous membrane is bound down and does not move when traction is made upon the pedicle. Upon section small cysts filled with a thick material may be exposed. In the recorded cases the growths have been most often on the base; the size has been that of a nut to an egg.

The stroma consists usually of fully-formed connective tissue, mixed with a few elastic and muscular fibers. In several cases, however, the connective tissue has been of the cellular embryonal type, which thus presented a sarcomatous appearance. The muscular tissue has been in several cases in great excess: Virchow indeed described under the name of myo-carcinoma a carcinomatous tumor whose stroma was entirely made up of muscular tissue. The epithelium is scattered regularly or irregularly throughout the stroma.

These growths are very vascular. The branches of the capillaries run out to the villosities and terminate in little loops. The villi are covered with several layers of cylindrical cells; between the villi the cells dip deeply into the stroma. (See Plate 4, Fig. 2.)

Throughout the mass of the growth the epithelium is present as the lining of gland-like tubes. Some of these tubes are very regular, with one or two regular layers of cylindrical cells and a clear lumen; others, however, are very irregular; the cells are of variable depth and regularity; the nuclei are irregular in size and location. In some places the cavity of the tubes is filled with the cells, so that an epithelial nest is produced. Very often cavities are present deep in the growth, lined with the same epithelium, which often extends into the cavity as a dendritic process. These cavities usually contain a gelatinoid material.

At the base of the growth the epithelial tissue pushes itself into the submucous or muscular tissue, with the production of nodules between the bundles of connective tissue or muscle. Quite large cystic cavities may be seen. Hemorrhage into the growth is not uncommon; the blood is often extravasated in the cavities as well as into the tissue.

A second form of vesical carcinoma is the epithelioma or the villous cancer. This form of growth is more common than the one just described. It is generally seated at the base of the bladder, and often seems to be multiple, although generally the different processes are connected. As a rule, it projects into the cavity, but a flat infiltrating form has been described. Nearly all of them possess a distinct pedicle, the insertion of which is infiltrated and thickened.

The crest of the growth is usually serrated and covered with fine villosities, with frequent hemorrhagic patches, which may be large and of a very dark color. The ordinary tumor may attain the size of an egg, and even larger growths have been seen. Surface ulceration is common; it may be extensive and deep: the surface of the ulcer is usually very soft.

Microscopically, these growths present a characteristic appearance. The stroma is scarce, composed of fully-formed connective tissue, with embryonal cells, elastic and muscular fibers in variable number. In the older parts of the tumor the stroma presents an alveolar structure, but in the more recent part it simply represents a delicate layer between the tubules of epithelial cells.

The vessels are numerous, rather irregular in arrangement, and are often dilated. The mass of the tumor consists of solid tubules of epithelial cells. This epithelium is irregular in type. The arrangement is that of a pavement; the cells are oval or irregular, and intimately bound together. The nuclei are small and irregularly situated. The typical epithelial columns are best seen in the young portions of the growth; in the older parts the arrangement is much less regular.

Colloid degeneration may be seen in small areas. There are no cylindrical cells of the normal mucous membrane to be found upon the growth; the mucous membrane is usually destroyed up to the insertion of the pedicle, and sometimes farther along the bladder-wall. The columns of cells push their way into the bladder-wall and likewise extend laterally. Albarran has described growths in which the arrangement was not tubular, but lobular. Hemorrhagic areas are not uncommon.

Closely allied to this form is the reticulated epithelioma described by Albarran, in which under low powers the arrangement was seen to be precisely that of a lymphatic gland, which under higher powers was seen to be made up

PLATE 4.

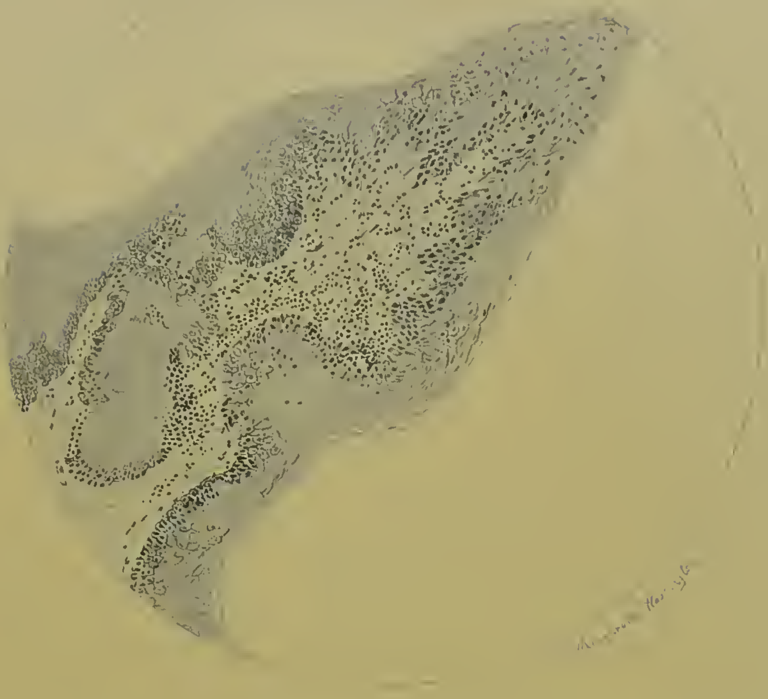


FIG. 1.—Tuft of papilloma of the bladder. (Thionine, × 90.)

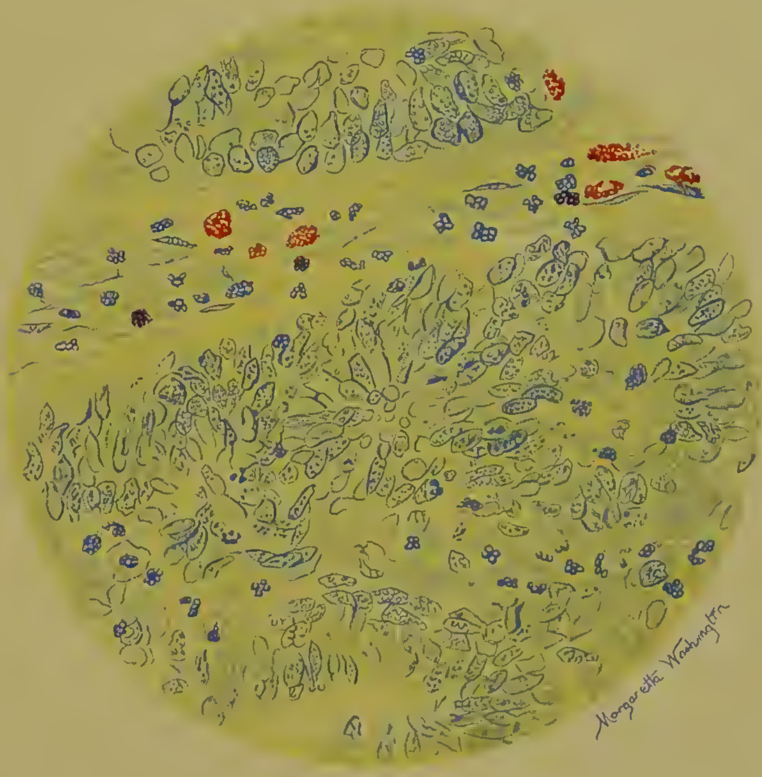


FIG. 2.—Cylindrical carcinoma of the bladder. Leukocytes and mast-cells in stroma. (Thionine-orange-G, × 500.)

of polymorphous epithelial cells. The same author has also described a tumor in which myxomatous degeneration of the stroma had produced the appearance characteristic, in other parts of the body, of a cylindroma.

Another important form of malignant epithelial growth is the alveolar carcinoma, the typical vesical cancer. According to the varying relations of the fibrous and cellular tissues, these tumors may be hard or soft, the latter the more common, and they may become colloid. They are usually situated upon the base, but may spring directly from the trigonum or from the lateral walls. There is usually one tumor or several growths connected by areas of infiltration, but there may be multiple growths. In a few instances there was an infiltration of nearly all the bladder-wall. It has in some cases seemed that where a tumor of one side of the wall touches the opposite wall secondary inoculations have occurred.

In most of the well-studied cases the growth of the tumor has stopped at the borders of the ureteral orifices, and has not infiltrated their walls; but in other cases this rule has not been observed.

The form of the alveolar carcinoma may be very varied. A long-recognized form is the cauliflower-shaped encephaloid of the older writers. This is usually a large growth, and is composed of a mass of irregular tufts surmounting a wide base. This base is intimately attached to the entire thickness of the bladder-wall, and is surrounded by a well-defined area of marked induration. The surface may be covered with fine villi or with tuberculous nodules. They may be very large, and are generally accompanied by several small adjacent growths.

In rare cases an attempt at pediculation has been observed. The consistency of these growths is quite soft, and there may be, furthermore, areas of necrotic softening which are semi-liquid. Ulceration is usually present, sometimes to a marked extent, and evidences of superficial and deep hemorrhages are abundant. The color may vary from gray to a deep brown.

Another form of alveolar carcinomata are the flat cancers. These appear as broad, shallow plates resting upon the mucous membrane, and intimately bound to the deeper tissues, which are indurated. They vary in size from the dimensions of a small coin to such an extent as to cover half the bladder-wall. They are usually multiple. The surface may be covered with a few villi, but more often it is ridged and nodular, with an occasional patch of ulceration or hemorrhage. The consistency, except in certain areas, is quite hard.

Another form, more rare, is the infiltrating carcinoma. In this case the bladder-wall is much thickened, very hard and inelastic, and the capacity of the bladder is much reduced in an advanced case. The surface of the mucous membrane may present no abnormal appearance, but may present small villi or tiny cysts. Ulceration is rare in this type.

Another form is the carcinomatous ulceration. Although any form may ulcerate, in this variety the ulceration is the chief characteristic. The surface of the bladder presents an ulceration of ragged outline and varying depth. The edges are hard, and there is an area of infiltration which passes beyond the ulceration. The infiltration is, however, so slight that it may only be upon section that the carcinomatous nature of the process is determined.

The protruding, the flat, and the infiltrating forms may coexist in the same bladder. Certain accidents of nutrition occur to all of them; certain areas become converted into soft yellow material, with quite the appearance of caseous degeneration. Hemorrhages frequently occur. They may be localized or infiltrating—in the first instance with the production of a cyst or an area of degeneration, and occasionally an abscess. Cysts filled with simple fluid or with gelatinous material are common. Areas of actual gangrene are rare, but do occur, and the breaking down is in these cases very rapid. Areas of calcification (not calculus) are rare.

Colloid cancer is very rare. Less than a dozen cases have been described, and in most of these the growths were large and implicated the other pelvic tissue; in fact, it was not fully demonstrated that the growths were primary in the bladder: this has, however, been shown in two cases (Guyon and Lancereaux) in which only the bladder was affected. The larger tumors were notable for their extent, rapid growth, and the anatomical and physiological implication of the ureters, kidneys, and intestines. The appearance is that of colloid cancer elsewhere—a dense network of fibrous tissue, with lobuli filled with the mucoid material. Colloid cancer has no relation to the colloid degeneration of the bladder-wall of Rokitansky.

The relations of the various types of alveolar carcinoma to the rest of the body are alike, and can be considered together. Extension by contiguity is not the rule in vesical cancer, rather the exception. Generally the growth stops at the adventitial connective tissue. In a few cases, however, it has extended beyond the bladder. Nodes have been found in the prostatic urethra, generally on the crest; the growth may extend into the prostatic gland or along the urethra, and then usually diminishes the caliber of the canal. In a similar way the mouth of the ureter may be attacked, but the process is not extensive. Fenwick has described a case in which the growth ascended the ureter and formed a muff. Complete occlusion (obliteration) of the lumen of the ureter has been described.

Extension from the exterior aspect of the bladder-wall may involve the prostate, the seminal vesicles, the colon, the small intestine, the uterus and adnexa, the soft and bony tissues of the pelvis, the peritoneum, and the abdominal wall. Of the portions of the colon, the sigmoid is most often affected, but even the caput coli has been involved. Ulceration of the intestine may occur, but the rectum is rarely affected. The growth may pass out of the pelvis by the greater sacro-sciatic foramen and involve the sciatic region, with inclusion of the nerves; it may grow anteriorly and appear in the groin. The vagina is rarely involved; it is, however, sometimes attacked with the rectum, thus resulting in vesico-vaginal fistula. Secondary glandular and metastatic deposits are not more common than extension by contiguity. The lymphatic glands most likely to be involved are the pelvic and retroperitoneal, but they seldom enlarge to a great size. The lumbar glands are rarely enlarged. It is important to note that the inguinal glands have been affected, also that secondary deposits have been seen in the cavernous bodies (Guyon). There may be nodules in the kidneys, and they have been seen in the liver, spleen, lungs, pleura, and in the dura mater. Ulceration may occur in any of the secondary growths, but are most common in the extensions by contiguity. Perforation of the wall of the bladder has been several times observed, usually located at the top. If the opening be small and of gradual formation, intestinal adhesions generally shut off the peritoneal cavity effectively, but in some cases perforation has permitted the urinary contents to enter the general abdominal cavity.

The microscopical appearances of alveolar carcinoma vary largely according to the relative proportions of cells and connective tissue. The general arrangement is that of bundles of stroma surrounding epithelial nests. The stroma is composed of fibrous connective tissue, which is in large amount in the scirrhous form. Mixed with the fibers are elastic fibers, occasional muscular fibers, strands of myxomatous tissue, and not infrequently there are areas of round-celled infiltration. Deep in the tumor the stroma is more massive than at the periphery. In the encephaloid form the strands of stroma are delicate, and the alveoli are much larger than in the hard form.

Deep in the tumor the blood-vessels are in excess; their walls are at times affected, and the lumen of the veins may be obliterated by the growth. The alveoli are filled with polymorphous epithelial cells, whose nuclei are small, distinct, irregularly placed, and sometimes seen engaged in cell-division. The intracellular bodies (coccidia?) have been beautifully demonstrated in these cells. In some areas the cancer-cells are seen to be in various stages of degeneration.

There is usually no normal mucous membrane covering the growth, but patches may remain. From the center to the periphery the alveoli grow larger. Small or larger cysts are often seen; they are usually filled with a thick substance which takes the acid-aniline stains.

In the bladder-wall, besides the growth, the area of induration is seen to derive that character from an infiltration of the cancerous cells. These push downward and laterally between the bundles of fibrous tissue and muscle, which degenerate and atrophy, and thus a wide area is usually markedly cancerous. Ulceration and hemorrhage are seen in many sections.

Colloid cancer appears to be composed of a heavy fibrous stroma with the spaces filled with mucoid material. Epithelial cells are rare; in many sections none can be found, but in the younger portions of the tumor nests of cells may be seen, many of them apparently in the process of mucoid secretion, while many others are seen to be affected with fatty degeneration.

Secondary Carcinomata of the Bladder.—These are much more numerous than the primary growths, and are more common in the female sex. In women they are often secondary to cancer of the vagina, uterus, and adnexa; cancer of the rectum is the common primary growth in men.

More rarely, the bladder-neoplasm is secondary to cancer of the prostate and genitalia. In these cases the growths are of the nature of an infiltration, usually with little ulceration. In any case the site of attachment determines the phenomena. Metastatic nodules have been found in the bladder in cases of genital cancer of women; Marmaduke has described vesical metastasis in a case of cancer of the cavernous body. Colloid cancer has spread to the bladder from the abdominal cavity. In any case the histological characters of the secondary tumor depend upon the nature of the primary growth.

The Epithelial Cysts of the Bladder.—There are rare cases of cysts in the bladder-wall which bear no relation to dermoid cysts, ureteritis cystica, those cysts which arise from embryonal remains of the uro-genital tract, or from congenital malformations. On the other hand, they must be separated from cystic degeneration of the glands and from the retention-cysts which are seen in cases of chronic cystitis. Whether these cysts are true tumor-formations or are of inflammatory origin is not yet definitely decided. They are usually multiple, although large single cysts are seen. They are most often situated upon the base and the trigonum, about the opening of the ureters, and at the neck of the bladder. They may cover the entire vesical surface, and have even been seen in the urethra. In most of the cases described a dozen or more small cysts were present about the size of peas, situated in the mucous membrane and filled with an opaque fluid. In a few cases they were as large as a walnut. They may become pediculated: Vincent de Lyon described in the case of a child a cyst—which may not, however, have been of this type—

which possessed so long a pedicle that it passed out of the urethra and presented at the vulva.

The structure of these cysts consists of connective tissue and a lining of cuboidal cells, with occasional areas of stratified cylindrical cells. The contents are of a mucoidal nature. It seems probable that they arise from localized epithelial proliferation, according to which they should be classed with neoplasms.

B. **Tumors composed of Tissue whose Type is a Variety of Connective Tissue.**—Some of these growths are benign, others are malignant. They will be considered individually.

Fibroma.—Growths classed as fibromata were first described by Rokitansky and Virchow. They are rare. Men are more often affected than women, and they are generally found in the adult, though they have been seen in infants. They are usually located upon the base and trigonum, and are nearly always single.

The size varies from that of a nut to that of an egg, and even larger growths have been seen; they may be sessile or pediculated, hard or quite soft. The surface is lobulated and covered with normal or inflamed mucous membrane, which may or may not be firmly attached to the growth. When sessile the growth does not infiltrate, but can be easily enucleated, being distinctly encapsulated; there is no induration around it. On section the tumor is white and glistening; there may be patches of myxomatous softening or areas of calcification.

Microscopically, the mass of the tumor is composed of adult fibrous connective tissue, with here and there a few elastic fibers and patches of fusiform cells whence the growth proliferates. There are usually many streaks of amorphous substance which take the acid stains. In the tumor itself the blood-vessels are few, but around it they are plentiful and may be almost cavernous. There is no implication of the muscular layer of the bladder. In a few cases unstriped muscle-cells have been found in the growth, which was thus a myofibroma; it has also been mixed with myxoma.

The mucous membrane covering the growth may be entirely normal; in other cases it is inflamed. The epithelium is degenerated and there are areas of round-celled infiltration; or there may be tiny villous vegetations upon the growth, quite like the epithelial proliferation in papilloma.

Angioma.—There is only one properly-studied case of this tumor recorded —*i. e.* that of Albarran. The growth was small, situated midway between the mouths of the ureters, and provoked violent hematuria.

Myomata.—These are rare growths, and may be classified in two varieties, composed respectively of striped and unstriped muscle.

The leio-myomata, or smooth-fibered myomata, are met with in adult subjects, and most of the few cases have been in males. They are generally located about the orifices of the bladder, and are usually solitary. They may be sessile, but are more often pediculated. They have been noted from the size of a cherry up to such dimensions as to fill half of the cavity. The pedicle is short and thick.

The mucous membrane covering the growth may, as in the case of fibroma, be normal, inflamed, or covered with sparse vegetations.

The tumor is usually hard, though there may be areas of softening, and on section considerable elasticity is noted. In a few cases myomata have not projected into the vesical cavity, but have remained interstitial, producing a thickening and induration of the bladder-wall. In other cases the growths have protruded outward instead of inward, so that it finally constituted paravesical tumors, to which Belfield first called attention.

The microscopic structure of the growths quite resembles that of the myofibroma of the uterus. The tumor is divided into lobules by connective tissue; its main bulk is composed of unstriped muscle-cells, in some places arranged in fasciculi, in others irregularly grouped. In the sessile and mural forms this tissue is directly continuous with the muscular layer of the bladder-wall, and even in the pediculated growths this direct connection can usually be established.

The epithelium covering the growth presents no alterations beyond inflammation and vegetations, which are not the rule. The vessels pass directly into the growth or through the center of the pedicle; the veins are often dilated and surrounded by hemorrhagic extravasations; the submucosa covering the growth is very vascular, may appear cavernous, and may contain extravasated blood.

Not all of the myomata are pure; they may be mixed with fibroma, myxoma, or sarcoma, under which circumstances the growths and the microscopic appearances are correspondingly altered. The occurrence of muscular tissue in carcinomata has already been mentioned, but the author does not think that such cases should be termed mixed tumors. In any case careful study of the tissue adjacent to the tumor must be made in order to exclude prostatic growths. The paravesical myoma will be again considered under Paravesical Tumors.

Rhabdomyoma.—Only one case of this remarkable vesical neoplasm has been described (Vicenzi). The subject was a child of thirteen years; the posterior base was affected. Cattani has, however, described a vesical polyp which contained striped muscle-fibers.

Myxoma.—Myxomata of the bladder are, comparatively speaking, frequently seen. By the older writers they were believed to have been very frequent, but it is evident that papillomata and mucous polyps were often classified as such. They are, however, rarely pure, being generally mixed with fibroma, myoma, or sarcoma. They are usually seated upon the base and the trigonum, but may spring from any part of the wall; they are commonly multiple.

The majority of these growths occur during the early years of infancy; after the fifth year they are rare, although myxoma has been seen in old age. The sexes seem to be equally affected. These growths may be pediculated or sessile. When multiple they are generally small, but from their number may almost completely fill the bladder. The surface may be smooth or lobulated; exceptionally the growths may be so grouped as to resemble the so-called hydatidiform mole. Small villosities may surmount the surface, but this occurrence is exceptional. When pediculated the pedicle is short and thick, but may be long and slender and allow the growth to float about.

Myxomata are usually soft, but the consistency is not uniform: some areas may be hard, while others are edematous and fluctuate. The color varies from a semi-transparent gray to a dull red, and areas of hemorrhage are often seen. The attachment is to the mucous membrane only.

The microscopical appearance of these growths is very striking. The bulk of the tissue is made up of a homogeneous proteid substance which stains with most acid stains, and especially well with thionin. Here and there are fine fibrillæ, with occasional strands of fully-developed connective tissue. Cellular elements are usually not abundant, and their distribution is irregular. In some instances these cells have been of the type of embryonal round-cells—*i. e.* cells with small central nuclei and a large quantity of protoplasm. In other cases the tissue has resembled the connective tissue of the allantois, which fact is very suggestive when taken in connection with the case reported by Winckel from a child one day old, in whom the growth must have been congenital. Usually the cells are triangular or spindle-shaped, and prolongations run from them into the surrounding substance. Cells resembling the plasma-cells were described by Clado, but it is questionable whether these were identical with the plasma-cells of Waldeyer. In a growth recently examined by one of us the majority of the cells were filled with large basophilic granulations: about them, however, no cell-outline could be detected, and there were no fibrillary prolongations from the cells, whose nuclei were pale and presented in sharp outline one or more well-stained nucleoli.

The blood-vessels are very abundant, the capillary network being particularly well marked. The vessel-walls are, however, except in myxomata mixed with sarcoma, of normal structure, and the surface is usually covered with a thin layer of normal epithelium, but this is often absent in places. Superficial ulceration is rare. Hemorrhages may be seen in any part. The myxomatous tissue does not extend wide of the insertion of the growth or pedicle; there is, therefore, no infiltration and no histological appearances of malignancy. (See Plate 5, Fig. 1.)

Sarcomata.—These are rare growths in the bladder—not more common, probably, than either fibroma or myxoma, with which they are often mixed. In 1892, Albarran collected from the literature 52 cases of primary sarcoma in which the diagnosis was verified by microscopical study, which, it is admitted, was not in all the cases thorough.

The cases have been about equally divided between the sexes. Any age may be affected, but one-third of the cases occur under the tenth year. Any part of the bladder may be affected, the base, trigonum, and posterior wall, according to the statistics, being most vulnerable. The growths are usually multiple; the size varies from that of a walnut to that of an apple, and the cavity of the bladder may be almost obliterated by the mass.

These growths are in their nature sessile: in a few cases there has seemed to have been a tendency to pediculation, but this has never been fully developed. They are intimately attached to the entire bladder-wall, and there is an area of induration about them. The surface is usually smooth, but may be lobulated, and, like any other vesical tumor, may be covered with small villosities. The growth is firm to the touch, and may be uniformly hard or may present areas of softening. The color is dark, and many brown spots testify to the existence of hemorrhages. Small cysts, and even abscesses, have been seen in the interior of the growths.

On section the growth is of a flesh color, and the section may reveal a cyst, a hemorrhage, a spot of calcification, or a pocket of pus. Sarcomata are mixed with fibroma, myxoma, chondroma, and angioma, and in such cases the appearances are correspondingly altered.

The induration about the growth is the sign of lateral infiltration. There seem to be several favorite directions of extension: one is along the urethra; this has been most frequently seen in women in whom these growths have presented at the meatus; in no case have the ureters been attacked. Of paravesical extension the anterior direction with involvement of the symphysis, and the posterior with involvement of the sacrum, are the most common, although any part of the bony pelvis may be affected. The prostate and the retroperitoneal lymphatic glands are usually spared, and among the

PLATE 5.

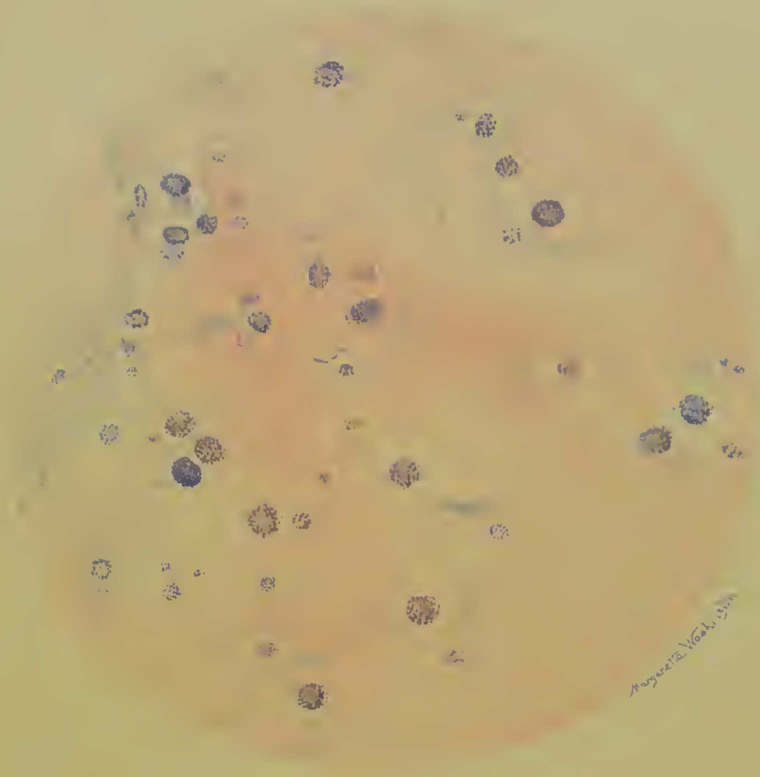


FIG. 1.—Myxoma of the bladder. Mast-cells in great numbers. (Thionine, × 500.)

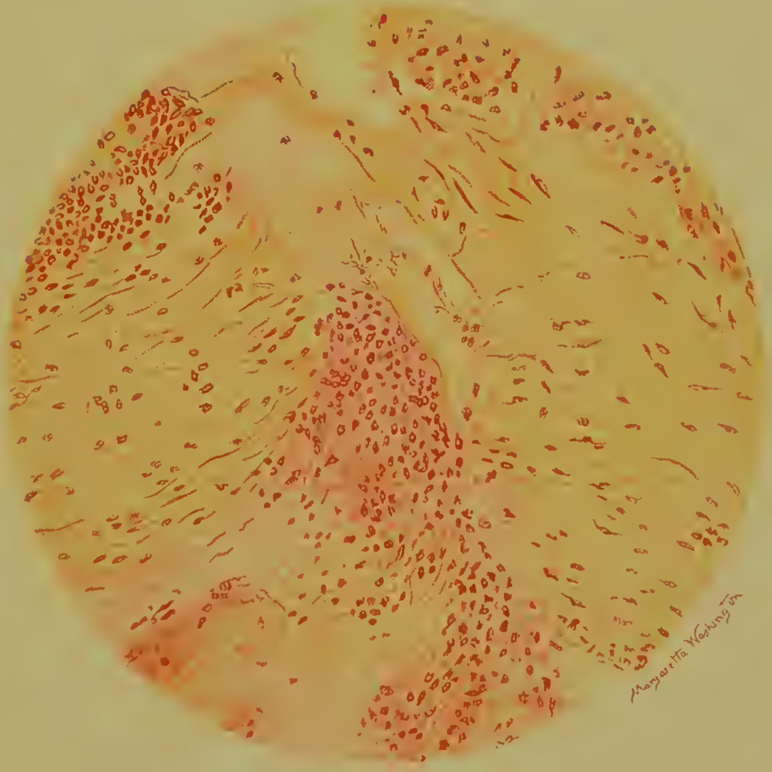


FIG. 2.—Sarcoma of the bladder; infiltration of muscularis. (Neutral red-orange-G, × 100.)

recorded cases the intestines were affected but twice. Extension by metastasis is rare, although secondary growths have been found in the spleen, liver, and lung. Secondary sarcomata of the bladder have been rarely seen as the result either of direct or metastatic extension. Melanotic vesical sarcomata are rare, and are always secondary. (See Plate 5, Fig. 2.)

Microscopically, the sarcomata correspond to many types. Small and large round-celled, spindle-celled, giant-celled, the mixed forms, teleangiectatic, and alveolar sarcomata have all been described in the bladder, and, with the occasional presence of cysts, abscesses, hemorrhages, areas of calcification, and the other neoplasmic tissues which may be mixed with them—fibroma, myxoma, and chondroma—this divergence of histology makes the appearances of different growths extremely varying.

The round- and spindle-celled sarcomata are the common forms. The tissue is usually almost entirely cellular, though in various cases more or less fibrous tissue will be found. The cells are irregularly arranged, as a rule, the nuclei stain well, and in the newer portions of the growth are evidences of cell-multiplication. The blood-vessels are usually only channels with a lining of endothelium or even of pure sarcoma-cells: well-developed vessel-walls may, however, be seen in any case of sarcoma. The superficial portion of the growth may be covered with the normal vesical epithelium. In other cases there are minute villosities or patches from which the epithelium has disappeared or where ulceration is present.

In the bladder-wall the infiltration is represented by columns of cells pushing their way between the strands of fibrous tissue or muscle. The mixed tumors present varying appearances in the different cases, but the diagnosis of sarcoma can always be made by the finding of true sarcomatous tissue in some part of the growth. The secondary melanotic growths are characterized by the well-known pigment infiltration.

Enchondroma.—Two cases of primary enchondroma have been recorded (Beraud and Pfenninger), and one of secondary involvement has been reported by Chalvet. The primary growths were very small; the secondary growths extended from an enchondroma of the thigh. A mixed tumor (chondro-myxo-sarcoma) has been described by Shattuck.

Osteoma.—Dupuytren and Middleton have observed cases of osteoma of the bladder-wall (Civiale). In both instances there were symptoms of stone, and both were sounded. In each subject there was found post-mortem an osseous tumor at the base of the bladder. In neither of these cases, however, has the possibility of a calcification or ossification of a fleshy tumor been excluded.

Angioma.—Two cases have been well studied (Langhans and Albarran). In each the mass of cavernous tissue was beside the ureters: Langhans' patient bled to death, and in the other case the hemorrhages were frequent and profuse. The tumors were small and composed of cavernous vessels with very thin walls.

Lipoma.—Three cases have been recorded (Barth and Sée). They consisted of small bodies in the submucosa, which pushed forward the mucous membrane, and were composed of fat.

Lymphadenoma.—One subject of this disease presented a nodule upon the trigonum (Murchison).

C. **Heterogeneous Tumors.**—The rhabdomyxoma and the chondroma ought strictly to be classed as heterogeneous growths. In the older writings dermoid cysts of the bladder were often mentioned. The phenomenon of pilimiction was well known, but no attempts until recent years have been made to study the matter and to separate the dermoid cysts of the bladder from those which merely empty into the bladder.

Of the cases recorded, Clado considers that only 8 have been primary in the bladder, but the question is made difficult of decision because extravesical cysts rupture into the bladder through the base, where the primary cysts likewise develop. With one exception the subjects were females. The growths are obviously congenital, but they may defer their clinical appearance until middle life. The site affected has been, as already mentioned, the base, the growth probably springing from the line of embryonal closure. In the case of Martini's, a male infant, there was atresia ani et urethræ; the colon opened into the posterior aspect of the bladder, while about this opening the bladder was the seat of a dermoid growth.

The growths are either pediculated or sessile. Their surfaces are rough, have a cutaneous appearance, and are covered with a greater or less quantity of hair. Cysts are usually present in the growth, but this is not always true. The tumor may be as large as an egg.

On section the heterogeneous nature becomes apparent; there are irregular areas of fat, fibrous tissue, almost fluid or hard as cartilage, and hair, etc. Microscopically, the growths are usually composed in the main of fibrous tissue and fat. Between these tissues, however, are seen pieces of cartilages, epithelium resembling the dermic epithelium, with fairly typical hair-follicles and sebaceous glands. The covering is not an even covering of epithelium, but when well developed the hair and hair-follicles, the papillæ, and the sebaceous glands are more typically developed than in the center of the growth. The bony areas occasionally seen are more probably calcareous than osseous.

The cysts may be very extensive or may be insignificant. Albarran has described several growths of analogous origin under the name of dermoid epitheliomata. These were composed of epithelial cells which resembled the dermic epithelium, and contained pearly bodies; they presented, however, none of the pilous or sebaceous structures. Dermic epitheliomata of the bladder have been previously described by Thompson and Winckel, but their dermic character was not fully demonstrated.

Hydatid Cysts.—These have been not infrequently seen in the bladder-wall. With one exception, however, they have all been paravesical, and will be considered under Paravesical Tumors. In the case of Sauvage, in addition to several abdominal cysts, one was located in the posterior wall of the bladder between the mucous membrane and the muscular layer. This had caused retention of the urine, but later ruptured into the bladder-cavity.

D. **Perivesical and Paravesical Tumors.**—There are various growths which involve the exterior surface of the bladder. They may be divided upon anatomical considerations into two classes—the perivesical tumors, which involve primarily the bladder-tissue, and the paravesical tumors, which are growths affecting adjacent tissues and involving the bladder organically or functionally.

The *perivesical* tumors will be first considered. In the description of leiomyomata it was noted that some of these growths grew from the muscularis centrifugally, and such a growth is a perivesical tumor (extravesical tumor of Belfield). Only a few such growths have been described. Isolated cases have been described in which perivesical growths were shown to have developed from the urachus (Palaillon) and the utriculus prostaticus (Verhaagen).

The other forms of perivesical growths are more or less connected with cystic processes. Several of the reported dermoid cysts have been strictly perivesical, involving the bladder-tissue, but growing outward. As a rule, however, they have been paravesical growths which have become attached to the bladder.

Another class of cysts somewhat allied to dermoid cysts are the cysts which develop from embryonal remnants. These are situated in the posterior and inferior wall, and are of four classes (Englisch)—those which have developed from the Wolffian duct, from the Müllerian duct, from the utriculus prostaticus, and from the seminal vesicles. The locations of these cysts are not the same: those of the Müllerian and Wolffian ducts are in the posterior median line, and may extend upward some distance, even as far as the kidney (Cornil). They are usually attached to the prostate. The cysts which arise from the utriculus prostaticus are likewise in the posterior median line and are attached to the base of the prostate. The cysts of the seminal vesicles are latero-posterior, in front of the prostato-peritoneal aponeurosis, but below the rectovesical sac of the peritoneum. Thus these latter are strictly paravesical cysts; the others are, however, usually incorporated within the bladder-wall. Segond has described a cyst in the posterior wall of the bladder as large as a walnut which had the appearance of a simple epithelial cyst.

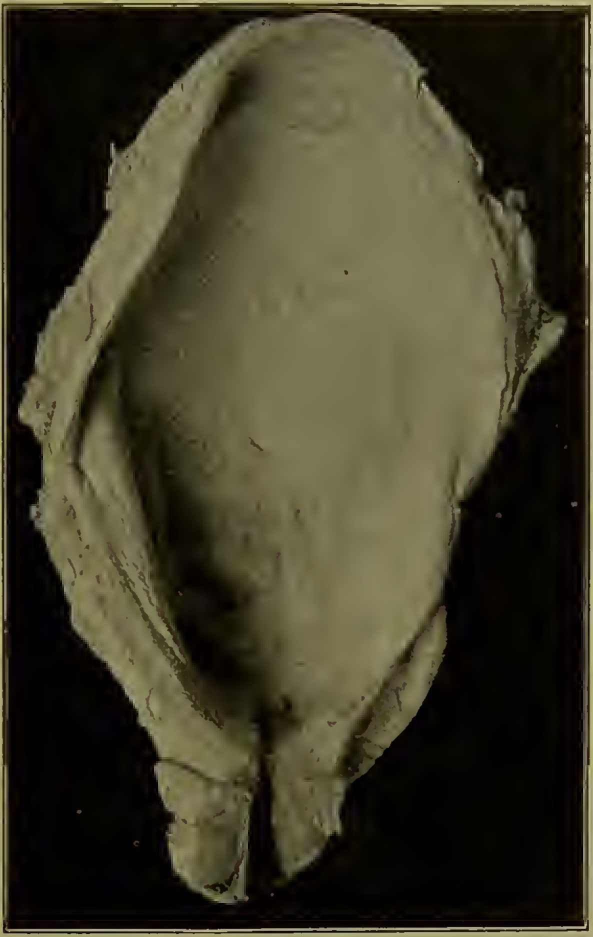


FIG. 115.—Retrovesical cyst with opening into bladder just above the trigone (Wistar Institute of Anatomy, Univ. of Penn.).

The *paravesical* growths are of many varieties, and include both solid and cystic tumors. Under the headings of Carcinoma and Sarcoma some mention has been made of vesical involvement from paravesical growths.

Any malignant disease, especially of the uterus or adnexa, the prostate, the intestines, the rectum, the pelvic bones, or the pelvic connective tissue, may become attached to the bladder and involve it. Any benign tumor of the pelvis or its contents may become attached to the bladder without extension (inflammatory adhesions), and thus produce vesical symptoms.

The majority of the pelvic dermoid cysts are paravesical. These cysts usually originate in the cellular tissue, the rectovesical tissue being the favorite site, although they have been seen to the sides and in front of the bladder. Very rarely an ovarian dermoid cyst becomes attached to the bladder. Dermoid cysts in this locality are often large, and may be so large as to rise into the abdominal cavity. As a rule, they sooner or later evacuate their contents into the bladder. Hydatid cysts likewise usually develop in this region in the paravesical cellular tissue, either posteriorly, anteriorly, or laterally. They may be single or multiple.

The locality of the cyst and its relations to the fasciæ determine its size and its direction of growth. If the cyst begins behind the bladder on account of the rectovesical fascia, it will push the bladder against the pelvis, and as it continues to enlarge it will ascend and grow over it toward the anterior abdominal wall. Cysts developing to the sides of the bladder tend to attach themselves to the pelvis rather than to the bladder. The prevesical cysts ascend toward the umbilicus and attach themselves to the summit of the bladder. As a rule, ovarian cysts do not adhere to the bladder, and affect it only by pressure. The rare coccygeal cyst may involve the posterior vesical wall.

Lesions Secondary to Bladder-tumors.—There are many lesions which are either caused by, complicate, or accompany tumors of the bladder, and these lesions often play an important rôle among the symptoms. The most important of these are the changes in the bladder. The capacity of this organ may be little affected (apart from the bulk of the growth). In some cases the capacity is diminished; in other cases it is increased. The diminution is effected in the same manner as in chronic cystitis; the dilatation is due to retention of urine, but the cause of retention is not always the same.

If the growth be situated just behind the vesical neck, it will cause a partial retention. If the pedicle of the growth is sufficiently long to allow it to be swept into the bladder by the force of the outflowing urine, a similar partial retention will result. In other cases clots of blood or fragments of tissue or calculi hinder micturition and produce dilatation. The dilatation, however, is not solely the result of the impediments to complete evacuation, but is due in part to disease of the vesical wall. In response to the obstruction to the flow of urine a muscular hypertrophy occurs, and secondary to the cystitis, which generally develops, the fibrous tissue of the submucosa hypertrophies. As the case progresses, however, the fibrous hypertrophy overcomes the muscular hypertrophy, the muscular tissue retrogrades, the bladder-wall becomes weakened, and dilatation results. There may be a localized atrophy and thinning of certain areas of the wall. It is obvious that these nutritional disturbances are of prime importance in the development of dilatation.

Retention commonly develops. Following it sooner or later comes microbic infection. There are cases in which septic infection does not occur; in these, however, retention of urine is slight or absent, and the growth has produced little or no congestion of the mucous membrane.

The degree of vesical inflammation varies greatly; simple catarrhal cystitis, ulcerations, membranous cystitis, and suppurative cystitis are most frequently seen. The tissue of the growth is often more deeply affected by these processes than the bladder-wall. The ulcerations are, as a rule, not extensive, but at times they are large and deep, and particularly when they affect the growth do they lead to marked destruction of tissue. The formation of a membrane is seen as a rule only toward the end of the case. As the infection spreads deeper in the diseased bladder there develops a round-celled infiltration and overgrowth of the fibrous tissue in the submucosa. At times, however, the infection is so virulent that instead of organizing the tissue breaks down, with the production of a mural abscess situated in the submucosa, from whence it may dissect up the mucous membrane or burrow into the deeper tissue. As a result of the chronic irritation the entire thickness of the wall becomes sclerotic, and clumps of round-cells are seen in all the coats.

The inflammation often extends beyond the outer coat, with the production of a pericystitis. This is usually sclerotic in type, appears late in the case, and is characterized by a marked increase in the perivesical connective tissue which may proceed so far as to form adhesions with adjacent organs. In a few cases suppurative pericystitis has been noted : such a formation would usually be the result of a deeper ulceration, but in several of the cases no such macroscopic route of infection could be found. At times the perivesical fat is much increased, and although the increase is usually most marked at the site of the tumor, it may also extend entirely around the bladder.

In regard to the whole question of septic infection in cases of vesical tumors, apart from surgical infection, it must be insisted upon that the prime factors are retention of urine and hemorrhage.

Vesical calculi are present in a goodly number of cases of bladder tumor ; the incrustation of a portion of the growth must, however, not be mistaken for a calculus. The stones are usually not of large size, rarely exceeding that of a cherry. They may be single or multiple ; are composed partly of urates, but mostly of phosphates, and may be purely phosphatic. Oxalate stones have been found in a few cases. Calculi must be looked upon as secondary formations. It is of course possible for a calculus to coexist with neoplasm, or even antedate it. But the conditions in the infected bladders affected with tumors represent so perfectly the full set of circumstances necessary to the formation of stone that we are compelled to believe them secondary in all cases in which the contrary is not demonstrable.

Outside the bladder the consecutive lesions, apart from extensions of growths which have been considered, are few. Pressure of the tumor may dislodge the sigmoid or the rectum, compress the rectum with the production of a partial occlusion or pronounced hemorrhoids. Pressure may also cause varicocele, and in a certain number of cases a chronic indurative epididymitis has been noted. Prostatic hypertrophy is quite often seen, but whether it is secondary to the vesical growth or the cystitis is difficult to decide. In a few cases there have been metastatic abscesses in various parts of the body.

The ureters are often affected. Apart from ureteral extension, which already has been described, the lesions are those of compression and infection. The common location of growths at the bladder-base explains the frequency of obstructing compression. Whether by involvement of the ureter or by a mechanical blocking of its mouth, the result, hydronephrosis, is the same. It must be borne in mind, however, that independent of ureteral obstruction retention of urine will alone produce a ureteral stagnation with slight dilatation. When to this is added obstruction, the ureteral dilatation becomes marked, and the duct may become as large as the small intestine, with thick fibrous walls. Septic infection naturally ascends from the bladder, and pyouronephrosis results. Ulceration may occur upon the mucous membrane of the ureter, and a pseudo-membrane may form, but this is rare. The ureteral lesions are usually bilateral, although usually more pronounced upon one side; rarely only one ureter has been affected. The ureters are often dislodged by the growth, and may be pushed far to one side.

The lesions of the kidneys depend to a large extent upon the involvement of the ureters. Whenever the ureter is compressed hydronephrosis must ensue, which becomes hydro-pyonephrosis when infection ascends to the pelvis. When, however, as rarely happens, the ureter is obliterated by the growth, hydronephrosis does not occur, nor suppuration unless it pre-existed: the kidney simply atrophies as it would following ligation of the ureter. Even when the ureters are not obstructed the kidneys present some contraction with thickening of the capsule, and, microscopically, a mixed nephritis, with the interstitial process usually predominating. The conditions, however, vary: in some cases the parenchymatous degeneration may be marked, in others the kidneys resemble those seen in primary interstitial nephritis.

Whenever a pyonephrosis exists there are apt to be areas of suppuration in the kidney. Usually the suppuration attacks the pyramids, but cortical abscesses are also seen. Naturally the organ becomes cystic, and the typical surgical kidney may be seen, but a degeneration so pronounced is unusual. The left kidney is involved oftener than the right, but this must be regarded as accidental. The renal lesions are seen three times oftener with malignant than with benign tumors; as a rule they are badly diseased in all subjects dead of malignant vesical neoplasm.

Symptoms of Vesical Neoplasm.—Since the most important symptoms and signs of bladder-tumors are those directly referable to the urinary tract, these will be first considered.

Hematuria is probably the most important symptom. It is exceptional for any vesical tumor not to bleed at some period of its existence, though a few such cases have been described. Bleeding is often the first symptom; according to Clado's tabulation, it is always the first symptom in the benign growths excepting in papillomata, in which it inaugurates the symptomatology in 90 per cent. of cases; 80 per cent. of sarcoma are first revealed by hematuria; and it is the first sign in 75 per cent. of carcinomata.

The quantity and circumstances of the bleeding vary greatly. As a rule it is intermittent, though in some cases the urine is never free from blood for months at a time. The accident is usually apparently causeless and spontaneous. In a notable number of cases, however, it has been brought on by fatigue, injury, exertion, obstinate constipation, or straining at stool. The attack may occur at any hour, often during the morning. The recumbent position does not protect against hemorrhage; indeed the contrary holds true. At the commencement of the attack the bleeding is often profuse; usually it diminishes after a few hours, following which there is a period when the urine is only faintly tinged with blood. After this succession of symptoms the course of the hemorrhage is apt to be irregular. Very often the cessation of bleeding is as sudden as its onset, all traces disappearing from the urine for days, weeks, or months at a time. Or a few cells may be constantly present, with now and then an irregular slight exacerbation. Sooner or later, it may be on the next day or not for ten years, comes another severe attack.

Although the hematuria of bladder-tumors is liable to be very capricious, still when a series of cases are taken together it will be obvious that the attacks gradually become more frequent. In some cases, hemorrhage once established, the blood never disappears, but is always present in moderate amount, and there are irregular periods of marked increase in the flow: such cases are rare, and the subjects soon become profoundly anemic.

The degrees of the hemorrhage in different cases or at different times in the same case deserve a more detailed description. The urine rarely presents any sign beyond the spectroscopic absorption bands, which in the case of these hematuriæ are usually those of oxyhemoglobin, although if cystitis be present in severe degree the fetid alkaline urine may show the bands of methemoglobin. Under the microscope the cells may be quite numerous. The usual degree of bleeding between attacks is sufficient to color the urine faintly, and it is often quite dark. Small clots may be present even after moderate hemorrhage. Not uncommonly large clots are formed which may pass the urethra or may obstruct it. A large clot usually appears at the close of a profuse hemorrhage, and may mark its termination. In other cases large clots are gradually formed by minute hemorrhages upon the growth, become in some way dislodged, and are then voided. The actual quantity of blood lost in an acute attack may aggregate a number of fluidounces.

The anatomical causes of the bleeding vary; the excessive vascularity of the growths and the delicate structure of the capillaries and their terminal loops predispose to hemorrhage. It is further favored by the alterations of the mucous membrane apart from the tumor, the formation of vascular villosities, and the development of cystitis. Ulceration, when not due to mortification, may also cause hemorrhage.

The frequency or degree of bleeding bears no relation to the size of the growth, nor is there a definite relation between the frequency and degree of bleeding and the variety of tumor. As a rule to which there are many exceptions, it may be said that the more soft and vascular and the less fibrous a growth is the more it bleeds. Thus angiomata and papillomata cause the freest bleeding, fibromata and myomata the least. The form of the growth also affects the amount of hemorrhage somewhat: sessile and infiltrating growths bleed less than pediculated ones. Other important factors influencing hemorrhage are the movements of the bladder, particularly its contractions in micturition. During an active contraction the venous return is partially obstructed, and the congestion of the membrane is thereby increased; moreover, the surface of the tumor may be injured by the pressure of the opposite wall. The extreme irregularity of the bleeding, however, shows the limited influence of functional activity of the bladder.

Cessation of bleeding, except when it is the result of pure congestion, is accomplished by occlusion of the bleeding vessel by clotting and thrombosis. Toward the close of many cases bleeding stops entirely, and this may be due to gangrene of the growth or degeneration of the pedicle, aided quite materially by the feeble circulation of the cachectic subjects.

Disturbances in the act of micturition are almost constant. Retention is a common symptom; it is usually partial, but a few instances of complete retention, with such distention of the bladder that its summit reached the level of the umbilicus, have been reported. The causes of retention are clots, pieces of tissue, or the tumor itself, which may be so seated as partially to block the vesical outlet, or may possess so long a pedicle that it can act as a ball valve. There is a rare spasmodic retention. The degree and consistency of clotting depend not only upon the amount of bleeding, but also upon the quantity of urine in the bladder and its acidity at the time of bleeding: the greater the quantity of urine, the less active is the process of clotting. The entire bladder-cavity has been filled with a solid clot. It is not necessary for clots to be large in order to cause retention, and this is especially true in old subjects whose bladder-walls are atonic.

Retention is usually temporary and intermittent. It is accompanied by pain, colic, a burning in the urethra, and an intense desire to micturate. As a rule the vesical detrusors, aided by the abdominal muscles, are able to expel the obstructing clot or fragment of tissue.

Incontinence of urine is rare in vesical neoplasm. It may, however, be produced either by the abolition of the function of the sphincter from involvement by the growth, a condition sometimes seen in women, or by extensive ulceration and destruction of the neck of the bladder, exceptionally occurring in men. Retention with incontinence is commoner than true incontinence, and is caused by an imperfect plugging of the vesical neck, preventing the sphincter from acting efficiently.

Frequency of micturition is another almost constant symptom, being present in many cases from the first onset of symptoms, while in others it appears only late in the case. It must be borne in mind, however, that the frequent urination truly symptomatic of tumor is painless, while the frequency of cystitis is accompanied by pain and the other symptoms of dysuria: the presence in the bladder of clots or pieces of tissue will also produce painful frequency.

The degree of the simple frequency varies in different cases and at different times in the same case. Usually the subjects urinate a dozen times in the twenty-four hours, quite often a score of times daily, and the act may become as frequently repeated as once every quarter hour. Exceptionally this symptom antedates hematuria; it usually appears with the first hemorrhage, but does not pass away with it. It is most marked in the tumors of the vesical neck.

Several cases of anuria have been described. It is, however, very doubtful, independent of the question of calculus or renal lesion, whether these were true instances of total suppression of the secretion.

Pain is very variable. Thompson laid great stress upon it, while Guyon maintains that, if cystitis and retention of urine be excluded, it is so often absent, and when present so variable in nature and intensity, that it does not constitute an important symptom. Pediculated growths cause less pain than those which are sessile or infiltrated; pain is most pronounced in tumors of the vesical neck.

Upon the occurrence of hemorrhage pain is nearly always present: there is an ache in the hypogastrium, a burning along the urethra, and if clots cause obstruction the suffering becomes severe and colicky. The pains of cystitis and retention are those which accompany these conditions when they develop independently of neoplasm. When the tumor has grown through the bladder-wall and attacked surrounding tissues a deep pelvic pain is common. By irritation or pressure of the lumbar branches neuralgoid pains of the areas of distribution may be produced, and severe sciatica has been caused by growth into the sacro-sciatic foramen.

The constitutional symptoms of uncomplicated bladder-tumors are usually mild. Unless the hemorrhages are severe and frequent the general health may remain long unimpaired. Profuse and frequent loss of blood will, however, cause rapid and pronounced anemia, evidenced by the characteristic appearance and symptoms. An examination of the blood will show a moderate oligocythemia, with perhaps some poikilocytosis, a more pronounced oligochromemia, and directly following the hemorrhages a moderate leukocytosis.

Typical cancerous cachexia, such as is seen in gastric and other internal carcinomata, is very rare in vesical cancer. The most important constitutional disturbances are due to cystitis and renal disease. There is, however, a toxic influence in malignant tumors due to an undetermined metabolic poison, produced or aroused by the neoplasm; and while this is present late in all the cases of malignant tumors, it is not possible to determine how much of the constitutional conditions is due to it and how much to septic and uremic intoxication.

Complications.—The most important of these is cystitis. Its pathology has been described elsewhere. It may occur early, and is the initial symptom in 25 per cent. of cancers, 33 per cent. of sarcomata, and in 10 per cent. of papillomata; it never inaugurates the symptomatology of other benign growths. In the benign cases it may be deferred until late. The advent of cystitis is largely influenced by hemorrhage and retention of urine; it causes painful and frequent micturition with tenesmus, the constitutional symptoms of an internal inflammation, as irregular fever with chills, and altered conditions of the urine. Late in the case the subjects may pass from septic intoxication into a low typhoid state, with the mental and functional derangement seen in the latter condition. In a few cases cystitis has been of the fulminant type and rapidly fatal. Usually the symptoms of cystitis are local and urinary, although that condition no doubt plays an important rôle in the gradual loss of strength.

Extension of infection to the ureter and pelvis of the kidney may be evinced by acute or subacute symptoms. Pains appear in the loins, of a dull nature, often colicky, and radiating into the genitalia. Fever is usually present, is irregular, may be hectic, and chills are common. Hydronephrosis or pyonephrosis promptly produces a tumor in the loin with its characteristic physical signs. As a rule, the symptoms of ureteritis and pyelitis are subacute. In these, as in any case of pyelitis or pyelonephrosis, a pararenal abscess is possible.

The kidneys are sooner or later affected in all cases of vesical tumor, and renal symptoms often dominate the closing period of the disease. Acute nephritis may be either parenchymatous or suppurative. In either case there will be oliguria and the other urinary signs of an acute nephritis (*vide* Urology). Fever will usually be present, more irregular in the suppurating form, and accompanied by chills. The gastric derangements are marked, and the mental and circulatory symptoms of acute nephritis are well developed.

The cases of simple acute nephritis usually pass into a chronic condition, but the subjects may develop severe acute uremia and die. In the septic cases the majority quickly pass into a low state of septic intoxication and die: some, however, survive the initial onset and develop chronic surgical kidney. The chronic nephritis may present either the parenchymatous or the interstitial type. Following an acute attack, the full train of symptoms of parenchymatous nephritis may develop—oliguria, dropsy, either general or local, anemia with the alabaster complexion, gastro-intestinal derangements, cardiac and respiratory distress, retinitis, chronic or acute uræmia, etc. More common is the interstitial form, in which the symptoms of renal insufficiency are less marked than the circulatory disturbances—cardiac hypertrophy, arterio-sclerosis, increased tension of the pulse, dyspnea, cerebral and digestive disturbances, etc. Chronic or acute uremia will appear in these cases sooner or later; uremia, in fact, is the actual cause of death in very many cases. Secondary metastatic deposits are often found post-mortem, but they occur so late in the case and are usually of such small size that they do not produce symptoms. If present, symptoms would obviously vary with the site affected, and need not be further discussed.

The secondary carcinoma of the bladder likewise presents few symptoms. As a rule, the growth is a mural infiltration, so that hematuria does not occur. Where there is perforation of the wall, as is sometimes seen in the pelvic cancers which have involved all the tissues, this would cause definite symptoms which would vary according to whether the perforation were into the peritoneal cavity, the pelvic cellular tissue, or rectum or vagina. Such phenomena are important in the consideration of the question of operation for extra-vesical cancer, but they are not important in vesical surgery.

Prognosis.—The duration of cases of bladder-tumor depends upon the site affected, the variety of growth present, the clinical course, and the occurrence of cystitis and nephritis. Tumors of the base, particularly those of the neck, are earliest fatal. Malignant tumors of the neck are usually fatal one year from the appearance of symptoms; rarely a case will go on to the second year, while a few do not survive over six months. The malignant tumors are usually fatal within two years even when situated in the less vulnerable parts of the bladder; there seems to be no difference in the duration of the carcinomata and the sarcomata. Extension beyond the bladder shortens the duration.

The benign tumors are in themselves quite compatible with long life: indeed, in several carefully observed subjects they existed ten, twenty, or even more years. The course of papilloma is largely determined by the hemorrhages and the complications: when the first are severe and frequent the duration is often not longer than is that of cancer, while even in the case of a papilloma which does not bleed the location of the growth may be such as to favor cystitis or obstruction of the ureter, with consequent nephritis, so that they may thus prove rapidly fatal. Hemorrhage and infection and obstruction are so likely to develop, even in benign growths, that these always must be regarded as dangerous. There are a very few cases (Ultzmann, Reverdin) in which spontaneous cure has been effected by the detachment of pediculated growths and their expulsion with the urine.

The causes of death are varied. Rarely profuse hemorrhage has been the direct cause. In the cachectic debility which follows prolonged hemorrhage the system is vulnerable, and any intercurrent disease may prove fatal. Many fatalities have been due to nephritis, a less number to septic infection. The toxic influence of malignant growths is undoubted, but it is important as a demoralizer of systemic resistance rather than as a direct cause of death.

The **urinary conditions** in bladder-tumor are important. The total quantity of urine is rarely affected by the tumor itself. In a few cases a simple polyuria has been noted. Oliguria is the rule as soon as a notable degree of renal complication exists, unless this be of the interstitial type with cardiac hypertrophy, when polyuria develops. A sudden oliguria suggests obstruction of one ureter, which later may be removed, being then followed by a temporary polyuria.

The color of the urine is often altered by the blood: it varies from a pale pink to a dark brown. If cystitis be present, the urine will be whitish and opalescent, with a heavy deposit of pus, phosphates, and detritus. Clots of blood and threads of mucus are common, and pieces of tissue of microscopic size have been found. The odor of the urine is normal, unless cystitis exists, when it is more or less offensive; late in the case it may be gangrenous. The specific gravity will correspond to the metabolic conditions of the patient: it will in the particular case be diminished if cystitis or nephritis exists, but the presence of blood naturally raises it. The reaction will be normal until cystitis occurs, when alkalinity becomes established. If much blood be present, its alkalinity will obviously neutralize the natural acidity.

The chemical examination is of importance in considering the question of the renal conditions. Whenever there is hematuria there is necessarily albuminuria present. To determine in an individual case whether the albumin is simply that of the blood in the urine or whether it is of kidney origin two methods are available: In the liquor sanguinis, as is well known, globulins exist in excess of serum-albumin, the ratio varying from $2\frac{1}{2}$ to $1\frac{1}{2} : 1$. In the albuminuria due to hematuria the ratio of the globulin to the serum-albumin will be the same. In renal albuminuria, for reasons which are not clear, the serum-albumin markedly exceeds the globulin, usually in the ratio of 12 to 18 : 1. This is true of every renal albuminuria, except that of amyloid disease and a few cases of very severe acute glomerulo-nephritis, which are characterized by a high proportion of the globulin, so that there the ratio drops from 12 to 16 : 1 down to 4 to $1\frac{1}{2} : 1$. In a given case, should the quantities of serum-albumin and of globulin be quantitatively estimated (amyloid kidney being excluded), if the serum-albumin-globulin ratio approaches the ratio characteristic of renal albuminuria, renal lesion is surely indicated; should the ratio be low, as 2 to 5 : 1, a mixed albuminuria would be suggested; should the proportion of globulin equal or exceed the proportion of serum-albumin, the diagnosis of a blood-albuminuria is almost positive. A second method is that of Goldberg: The red cells are counted from a well-mixed specimen of the twenty-four hours' urine in a Thoma-Zeiss hemocytometer. The percentage of albumin in the filtered urine is then determined by Esbach's method. If there be no more than 3000 blood-cells in the c.mm. of urine, and the urine give a reaction of albumin with nitric acid, the albuminuria is of renal origin, since that quantity of blood will not give such an albumin reaction.

In a pure hematuric albuminuria the weighed quantity of albumin in that amount of urine which contains the number of red blood-cells present in 1 c.mm. of the patient's blood will not exceed the proteid in the plasma of 1 c.mm. of blood, which is, even in anemias, not over 100 milligrams. Assuming that in hemorrhage the cells and plasma extrude in their circulatory proportions, and that the red cells have not given up proteid to the urine, any further amount of albumin would be of renal origin. This latter method has given useful clinical results in a limited number of cases, but has not yet been confirmed by operations or autopsies.

The urine should be carefully tested during the intervals when hematuria is absent, as an albumin reaction then indicates renal disease.

If cystitis be present, matters will be more complicated. To determine, in the absence of hematuria, whether an albumin reaction depends solely upon the pus or partly upon a renal condition, a small quantity of the twenty-four hours' urine, into which the pus has been intimately mixed, should be mixed with an equal volume of $\frac{1}{2}$ per cent. solution of acetic acid, colored with methyl-violet, and the pus-cells counted upon the ruled slide of a Thoma-Zeiss hemocytometer. With another specimen of the filtered urine the albumin is estimated in Esbach's albuminometer: 100,000 pus-cells in the c.mm. correspond to 1 per cent. of albumin, and a relative excess of albumin would imply a renal albuminuria.

Sugar is only accidentally present in the urine of these cases. Sulphuretted hydrogen is found in the urine of cases with a communication into the alimentary tract: it is furthermore present in severe cystitis independent of fistula.

The potassium salts are in excess whenever blood or pus is present and when decomposition of the tissue is going on. Under the latter circumstances the aromatic sulphates are also in excess.

The *sediment* is of great importance. The blood from vesical hemorrhages is usually mixed with the urine. Small clots are common. The blood-cells in fresh urine of proper saline concentration are usually well preserved and more or less crenated. In cystitis, however, the cells are often and markedly fragmented. The pus-cells are usually of the type of neutrophilic polymorphous leukocytes.

Epithelial cells from the bladder mucous membrane will be present in cases of cystitis: those of the superficial layers are small cylindrical cells of polygonal form, while those from the deeper strata are more oval and have long processes. In ureteritis and pyelitis epithelial cells would be desquamated, but they cannot be differentiated from the vesical cells. The cells are usually much degenerated. Renal epithelium may be present if the kidneys be severely affected. These are quite small polycylindrical cells with proportionately large nuclei, and are seen in all stages of degeneration.

Particles of the growth are not infrequently seen. If any particles passed be large enough, they should be put through the formal steps of fixation, dehydration, and imbedding in celloidin and stained; in this way a positive diagnosis can usually be made. Usually the particles are not large enough for this, and the sediment must be examined as such or may be smeared upon cover-glasses, fixed, and stained. Small villi of papillomata, the tiny central stalk covered with epithelium, are not infrequently seen: unfortunately, it cannot be told whether such filaments come from a papilloma or a simple mucous villosity, but we know that they are more often voided from neoplasms than from simply inflamed bladders. They must not be confounded with hyaline casts or fibers of fibrin to which cells have adhered.

Large layers of epithelium are sometimes seen, and these may come either from growths or from simple inflammation. Rather larger masses of tissue are sometimes passed: as a rule, from malignant growths. Isolated cells seen in the urine do not often furnish much definite information. If, however, many epithelial cells are present which are neither cylindrical nor polycylindrical, but are polymorphous and very irregular, the presence of a cancer is suggested.

Urinary casts are common. Even without definite renal complications hyaline casts may be present, due to anemia, malnutrition, etc. They are almost always found when pyelitis has become established and in interstitial nephritis. Whenever the renal tubules are affected, blood and leukocytic casts (in acute stages) and pale and dark granular casts are added to the hyaline casts.

The salts of the urine are simply the normal salts until cystitis develops, when a marked precipitation of the phosphates occurs. These salts often cling to the organic matters. Ultzmann believes that calcium oxalate is particularly excessive in the urine of cases in which the growth is necrosing.

Crystals of hematoidin are often seen in bloody urine of alkaline reaction: they are dissolved by acids and respond to Gmelin's test. In the rare cases of melanotic sarcoma of the bladder the pigment has been seen in the urine. It is, however, a question whether in extra-vesical melanotic sarcoma the pigment cannot be loaded into the blood and excreted by the kidneys.

Diagnosis.—This is founded upon the symptoms already detailed and upon direct examination.

The diagnostic symptoms are sudden, apparently causeless, profuse hemorrhages, recurring with increasing frequency and greatly aggravated by urethral exploration and the passage of fragments of neoplasm. Tough, coagulated fibrin or blood-clot so closely simulates fragments of neoplasm that a microscopic examination is necessary to determine the structure of the suspected body.

Direct examination is accomplished by palpation, sounding, cystoscopy, and cystotomy.

Palpation should enable the surgeon to detect all malignant infiltrating growths, except in unusually fat patients. Myxomatous and non-infiltrating growths cannot be detected in this way. It is always desirable fully to relax the patient by ether before beginning examination for vesical tumors. When the symptoms already detailed lead the surgeon to suspect strongly the presence of a growth, preparations for its removal should be made before conducting the examination, since, except the more advanced cases, this operation is always advisable and should be performed as soon as the diagnosis is assured. The patient should be etherized, his consent having been first obtained to operate in case a growth is found: the surgeon then proceeds to make his examination, the perineum, the suprapubic region, and the genitalia having been previously carefully disinfected.

Examination by rectal palpation is best left to an assistant who has acquired manual dexterity by experience. With the patient supine, knees flexed, and shoulders slightly elevated, the index and middle fingers of the right hand are passed into the rectum, while the fingers of the left hand press the bladder downward from above the pubis. The prostate, seminal vesicles, the ampullæ of the vasa, the base of the bladder, and a portion of its posterior wall can be felt distinctly. After introducing a catheter and drawing off all the urine, the bladder can be pressed down from above, so that practically all of its substance is within reach of all the rectal fingers. If distinct induration is felt, this indicates either stone or vesical tumor. Stone may be usually differentiated by its mobility and its harder feel. If no induration can be felt beyond a vague, semi-solid thickening, or if no departure from normal is perceptible, the surgeon next proceeds to examine the interior of the bladder with the cystoscope. The method of using this instrument is detailed elsewhere. It is sufficient to state here that it can render service only when the urethra is sufficiently patulous to allow it to be introduced into the bladder, and when this viscus is able to retain at least three or four ounces of fluid which will remain fairly clear for at least one or two minutes.

The cystoscope is best sterilized by formalin vapor. It is then dipped into a weak solution of silver nitrate or mercuric chloride or in sterilized normal saline solution to remove the irritating formalin from its surface, is lubricated with glycerin, the lamp is turned on to see that it is burning brightly, and the optical apparatus is examined lest it should have become clouded or defective. The current having been turned off, the instrument is introduced into the bladder. When vesical tumor is present, it usually happens that the fluid which has been injected, preferably normal saline or boric-acid solution, is opaque with blood. It should be remembered that the best medium with which the bladder can be filled is clear urine. Hence when the rectal examination is made, if the urine is free from blood, it is well to avoid emptying the bladder, the patient being etherized at a time when it is probable that this viscus contains at least four to six ounces.

It is particularly in examination for vesical tumors that the irrigating cystoscope will be found serviceable. The introduction of the instrument may occasion sufficient bleeding entirely to obscure the view. This may be transitory, and if bloody urine is allowed to escape through the irrigating tube and is quickly replaced by normal saline solution, a satisfactory examination may be conducted before sufficient blood has escaped to render this fluid turbid. If, after two or three efforts to fill the bladder with liquid sufficiently clear to permit examination, free bleeding persists, the attempt should be given up, the surgeon then contenting himself with an endeavor to find and inspect the ureteral orifice and watch for one or two jets of urine. If the jet from each side comes out clear into the turbid fluid, this will at once establish the vesical origin of hemorrhage. The cystoscope should then be at once withdrawn and the bladder further explored by suprapubic cystotomy.

Even when the conditions are favorable for cystoscopic examination considerable experience is required in placing the instrument so that the vesical walls are clearly seen, and in interpreting properly the conditions observed. There are a number of rules given in regard to the position in which the cystoscope should be held and the method of using it so that the entire bladder can be examined. The writers consider these of little service. The best possible teacher is experience. This should be gained, first, on phantom bladders, next on cadavera, next on sexual hypochondriacs, who are benefited by all forms of instrumentation, and finally on patients who present symptoms of vesical lesions. The cystoscopic appearances of the normal and diseased bladder are given at length under a special heading. The surgeon should remember that the rugæ of the imperfectly-distended bladder may closely simulate polypoid growths, that the surface of nearly all tumors becomes papillomatous, that tubercular infiltration and ulceration may be extremely difficult to distinguish from neoplasm, that the normal projection of the ureteral orifice may be mistaken for a polyp. Moreover, vesical growths in the presence of cystitis may become encrusted with phosphatic deposit, thus presenting the exact appearance of stones. If scraped with the tip of an instrument, this deposit will be loosened. Submucous hemorrhages, such as are common in hemorrhagic cystitis, may form gelatinous rounded elevations very like papillomata, only to be distinguished from them by the hemorrhagic stains and blotches of the surrounding mucous membrane.

The cystoscope is utterly useless in the hands of one who has no experience in its use, excepting in the diagnosis of the long, fringed papillomata, which present a perfectly typical and unmistakable picture. When employed by the surgeon who has so familiarized himself with it that he is able to appreciate the size of bodies and their position, it is of the greatest service, often saving patients from useless operations by determining, for instance, the renal origin of a hemorrhage which is supposed to be cystic. The writers believe that the cystoscope should never be used upon patients suffering from vesical neoplasm in whom cystitis has not developed, excepting just before operation.

When the cystoscope fails because it is impossible to introduce it or because it is impossible to keep the bladder moderately filled with a clear fluid, diagnosis may be established by either perineal or suprapubic cystotomy.

In choosing between these two operations the surgeon should select the latter, since if a tumor is found he is then in position to proceed at once to remove it. Some growths are accessible and removable through a perineal opening. The operator is, however, compelled to work in the dark, and cannot be sure that every portion of the neoplasm has been taken away, and there is danger of extensively injuring the vesical walls. Suprapubic incision renders the intravesical cavity accessible both to touch and sight.

Treatment.—*Palliative treatment* of tumors of the bladder is limited to the relief of hemorrhage and the control of pain. This treatment is often required because patients are reluctant to submit to operation—more often because by the time the diagnosis is assured infiltration has extended so widely that radical operation is no longer possible. The general treatment of hematuria is that appropriate to the relief of vesical congestion; medicinal treatment is of little service, though ergot or ergotin, gallic acid, and hydrastis are usually given. Direct local treatment may be conducted by hot injections of alum four drams to the pint, fluid extract of hydrastis two ounces to the pint, or acetanilid two drams to the pint.

In the absence of cystitis moderate retention caused by clots is best left to itself. Should, however, vesical tension become pronounced, the clot should be aspirated by means of a large catheter and suction syringe or by the evacuating tubes and aspirator employed in litholapaxy.

If bleeding is persistent and is not benefited by injections or irrigations, continuous catheterization is indicated. If this is unsuccessful because of constantly recurring obstruction of the catheter by clots, perineal or suprapubic cystotomy, with the insertion of a large tube, is advisable. Should this means fail to arrest bleeding, and should life be threatened by its continuance, suprapubic cystotomy should be performed: the bladder should be secured to the parietal opening by sutures, and, a drainage-tube having been carried to the region of the ureters, the bladder should be firmly packed with gauze.

Pain dependent upon cystitis is best remedied by mild antiseptic irrigations. If it is persistent and severe, opium and belladonna suppositories are required.

The *operative treatment* of tumors of the bladder consists in their complete removal through a suprapubic opening.

The incision into the bladder is conducted as in suprapubic cystotomy for the removal of stone.

The surgeon should be provided with a catheter which can easily be passed into the bladder; an eight-ounce syringe, the end of which fits into the lumen of the catheter; two retractors; one glass vaginal speculum; crushing, cutting, and avulsion forceps; a wire écraseur; a Paquelin cautery; knives, long straight and curved scissors, hemostatic forceps, tenacula, straight and curved needles, a needle-holder, and a grooved director. The rectal bag may be omitted; its use, however, elevates the bladder and renders the operation somewhat easier. It is well lubricated with glycerin, passed into the rectum, and distended with not over six ounces of water when there is no reason for believing that the bladder has become weakened by a long, severe, lasting cystitis. Six to eight ounces of water are injected into this viscus through a long rubber catheter. In place of water, air is sometimes used, and answers as well. A four-inch incision is then made, beginning slightly below the upper border of the pubis and passing upward in the middle line. The skin, superficial and deep fascia are cut through between the recti muscles if possible; if the incision falls to one side, it should be deepened through the fibers of the rectus until the fascia forming the anterior wall of the prevesical space is opened, exposing the prevesical fat. The finger is then passed down behind the pubis with its pulp toward the bladder, and is hooked upward, dragging with it the peritoneum and its underlying fat. This tissue should not be torn, but should be cut through with a knife or scissors, the bleeding points being secured as they are divided. Every effort should be made to preserve its vitality, since a common and often fatal complication of suprapubic cystotomy is purulent infiltration of this tissue. The firm white wall of the bladder having been exposed, the knife is thrust through it and a cut two inches long is made. The finger is then introduced and a manual exploration of the vesical cavity is made. If this shows absence of tumor, the bladder is dried with a syringe attached to a catheter and sponges on sponge-holders; the patient is put in the Trendelenburg position, and by means of a headlight mirror the vesical cavity is carefully explored, the incision being enlarged if necessary, and the vaginal speculum being employed as a caisson if bleeding obscures the view; that is, the speculum is passed through the vesical opening, as suggested by Fenwick, until its end lies in contact with the vesical mucosa. The portion of mucosa thus included is dried with a sponge, and can then be readily illuminated by the electric headlight and inspected direct. By moving this caisson from place to place the greater part of the bladder can be explored.

If the tumor is found, the borders of the bladder-wound are secured to the skin by three temporary sutures, one applied on each side and one above at the upper extremity of the vesical wound. By means of retractors the abdominal opening is then held widely open, and the surgeon proceeds to the removal of the growth. If there is still insufficient room, the attachment of one or both recti muscles is divided and the bladder opening is enlarged to the extent required, care being taken in cutting upward not to enter the general peritoneal cavity. Myomata and adenomata are enucleated.

Small polypoid growths are seized in forceps, drawn forward, an elliptical incision is made about the base with a knife, and the entire outgrowth, together with its attached base, is removed. The resulting wound is closed by catgut sutures, which are carried to the bottom of the wound. If the growth is pedicled, but so large that it prevents the proper treatment of the base, the écraseur is thrown about it and the bulk of the tumor is removed. The base is then treated as already described.

When the tumor is infiltrating—*i. e.* malignant—attempts to remove it by the curette or the cautery are futile. The portion of the bladder upon which the growth is seated should be entirely extirpated: since this requires more room for its proper performance than excision of pedicled growths, the attachments of the recti muscles will usually require division. In the treatment of tumors which are known to be malignant it is well to employ the Trendelenburg incision. This is a transverse cut four inches long, slightly convex downward, and it is carried along the upper border of the symphysis. The attachments of the recti muscles are divided, and the prevesical space and the bladder are both opened by a tranverse incision; the bladder-wound should be as large as that of the parietes, and should be temporarily sutured to the latter. This incision renders the subsequent steps of the operation comparatively easy, but it is objectionable because of the likelihood of hernia subsequently developing.

Helferich, finding that the suprapubic incision, even though transverse, does not always give sufficient room for intravesical operations, particularly when the bladder-base is involved in the malignant growth, has proposed irregular resection of the pubis as a means of rendering the operative region more accessible. A transverse cut is made along the upper border of the symphysis, care being taken to avoid the spermatic cord. External to the pubic spine on either side the periosteum is detached, and by means of a chisel and mallet the central portion of the bone is cut away. This cut does not involve the obturator foramen, and hence does not affect the continuity of the pelvic girdle. The mid portion of the pubic bones thus loosened, together with the soft parts attached, is lifted upward, thus exposing the anterior surface of the bladder; a similar exposure may be accomplished by symphysiotomy. Helferich's subpubic route to the bladder cannot be recommended.

Excepting the trigonum and ureteral region resection of the entire bladder is practicable. When the neoplasm is limited to the extra-peritoneal portion of the bladder-wall the resection is made from within outward. The lateral walls of this viscus may be readily rendered extra-peritoneal by stripping up the peritoneum. In performing an operation for extensive resection of the vesical walls the anterior and lateral surfaces of the bladder are freed by a finger passed behind the pubis, and the entire infiltrated area, together with a certain amount of apparently healthy bladder-tissue, is cut away with scissors. The bleeding may be free, but is readily checked by clamps. The defect is closed by sutures placed either vertically or transversely according to the position of the resection.

When the trigonum and *bas fond* are infiltrated, curative operation is practically impossible. It is true that the ureters may be separated and implanted into the rectum and the greater portion of the malignant growth removed. Implantation of the divided ureters is practically always followed by an ascending nephritis, and by the time patients with malignant tumors in this position present themselves for operation involvement of neighboring lymphatic glands will already have taken place. We believe that under such circumstances the operation, even if immediately successful, materially shortens the period of life.

When the malignant infiltration has involved not only the bladder-walls, but the overlying peritoneum, a peritoneo-vesical resection is indicated. This is best performed as outlined by Clado: Through the ordinary suprapubic cystotomy wound the tumor is first separated, and as much of a pedicle as possible is formed. By means of fingers placed behind the tumor an effort is made to double the wall upon itself; this will appose the peritoneal surfaces just beyond the line of resection. The whole turned-in mass is then seized in a long pair of forceps. The bladder is then tamponed with sterile gauze, the cystotomy wound is partly closed, laparotomy is performed, and by means of a Lembert suture the two peritoneal surfaces, held in apposition by the long curved forceps, are permanently secured in position; a double line of these sutures may be applied. The abdominal wound is then closed, the vesical wound is again opened, the tumor is cut away, the pedicle being seized with smaller forceps placed on the sound tissue. The long forceps is removed, the bleeding points are secured, and the mucous membrane is brought together by a continuous or interrupted catgut suture.

Complete resection of the bladder for extensive malignant growth has always been fatal in the male. Clado and Pawlik have each reported one successful case in women. Pawlik freed the ureters from the bladder attachment and stitched them into the vagina, later removing the entire bladder. Catheters were then passed into the urethra through the ureters and the vagina was closed externally. After several operations the patient had an artificial bladder which could retain twelve ounces. A final report of the case was made two years after operation.

When but one ureteral orifice is involved and there is a chance for total removal of the infiltration, the ureter may be exposed by an opening through the bladder-wall, freed, and after resection of the infiltration and closing of the resulting wound may be implanted into the bladder.

Operative treatment of bladder-tumors may be briefly summarized as follows: (1) Tumors of the bladder, even those that are manifestly benign, should be subjected to operation as soon as their presence is definitely determined. (2) Whatever the position of the tumor, it should be reached by suprapubic cystotomy. (3) Pedicled and apparently benign tumors should be removed by cutting through the mucous membrane about the base of the pedicle with the scissors or a knife, the resulting wound being closed by catgut sutures. The galvano-cautery or wire écraseur should be used for the purpose of removing the bulk of the tumor and thus allowing the surgeon more readily to deal properly with the base. (4) Sessile and infiltrating growths of the upper and anterior lateral walls of the bladder should be removed by resecting the portions of the bladder-wall in which these growths are placed. This resection should be made extra-peritoneal by stripping up the peritoneal investment of the bladder. The resulting vesical defect should be closed by a double row of catgut sutures, the first row approximating the mucous membrane; the second including the muscular and fibrous investment. (5) Infiltrating growths involving the peritoneal investment of the bladder should be resected in accordance with the method described by Clado. (6) Malignant growths involving the trigonum and ureteral orifices may be removed, the ureters being divided above the point of infiltration and implanted into the colon or the bladder: the technique is difficult, the operation exhausting, the mortality high, recurrence is almost certain, and even should the cancer be entirely removed the patient is likely to perish of ascending nephritis. (7) After removal of a vesical neoplasm the suprapubic opening should be closed by a double line of catgut sutures, a continuous stitch approximating the mucous membrane, and a second accurately bringing together the cut edges of the fibrous and muscular coats. The prevesical space should be drained, except in those rare cases in which there has not been a pre-existing cystitis. Under these circumstances the abdominal wound should be completely closed, since there is reason for believing that the bladder-suture is much more likely to hold when this course is followed. (8) When the intravesical operation has not been extensive, the bladder should be drained by continuous catheterization. When there is left an extensive raw surface, as when an attempt has been made to remove vesical tumors of the base, the bladder should be drained through a perineal opening. If suprapubic drainage is practised, Guyon's double tube should be employed.

Many surgeons prefer always to drain the bladder through the suprapubic opening. Guyon states that with his tubes drainage is so perfect that the dressings and the gauze packing of the suprapubic region remain dry, and need not be changed for several days. The bladder-wound having been closed, the prevesical space is lightly packed with sterile gauze, the abdominal opening is closed by stitches, excepting at its lower portion, and the gauze dressing is applied and secured in place by adhesive straps or an abdominal binder or a double spica of the groin. The patient is placed on his back in the bed; the drainage-tube, whether it be perineal, urethral, or suprapubic, is carried into a urinal half filled with antiseptic solution, and the bladder is washed every four hours with dilute antiseptic solution, nitrate of silver 1 : 4000 or boric acid.

When suprapubic drainage is usually practised without closing the bladder tightly around the tube, the dressings become soaked with urine in a few minutes. Unless special precautions are taken to avoid this, the skin becomes inflamed and intensely painful. This complication is best averted either by avoiding suprapubic drainage or by suturing the vesical wall so tightly that the tube fits and allows no leakage about it. If no sutures are applied to the bladder-wound, the patient's skin should be thickly coated with ointment of zinc oxide made stiff by adding four drams of finely powdered zinc oxide to the ounce of ointment. The patient is placed on an oakum pillow enclosed in gauze; large wads of absorbent cotton and sterile gauze are placed about the bladder-wound and are changed every two hours; the gauze packing employed in the prevesical space is changed twice daily, the space being carefully irrigated each time.

The vesical opening usually closes in two or three weeks; the drainage-tube is removed about the fifth or seventh day.

VESICAL CALCULUS.

By FRANCIS S. WATSON, M. D.

Formation of Stone.—The relative frequency of the primary occurrence of stone in the kidney and bladder is variously estimated: Heller, for example, makes the proportion that of 100 in the former to 1 in the latter; this disproportion is considered by most authors to be too great. It is undoubtedly true that almost all stones having uric-acid nuclei originate in the kidney.

Stone will not form primarily in the normal bladder; that is to say, in a bladder which empties itself freely and completely, whose mucous membrane is not inflamed, whose muscular apparatus has undergone no pathological change, and where there is no obstruction to urination present in the urethra, such as stricture or an exceedingly narrow meatus. It follows, therefore, that the largest number of stones in the bladders of patients under forty years of age, and of women—the latter because of their short urethræ—originate in the kidney, whereas in elderly men—owing to the loss of expulsive power, obstructive prostatic disease, residual urine, changes in the form of the bladder, and the frequent occurrence of alkaline decomposition of the urine—the larger number originate in the bladder.

Sir Henry Thompson calls attention to the relatively great frequency of stone in old men: of 993 male patients—adults and children—operated upon by him, 639 were between the ages of fifty-one and seventy years; of these it is fair to assume that the stones were formed primarily in the bladder in the large majority of cases. Clinical evidence also supports this view, for in most of the cases of old men evidence of renal calculus is absent, whereas it is frequently present with younger patients and women.

Ultzmann's view with regard to the manner of stone-formation is as follows: that it takes place by a process of actual crystallization similar to that occurring in geological formations. This theory is not generally accepted, and is contradicted by the demonstration of the presence of a colloid framework which favors the aggregation and firm adhesion of particles of the urinary salts. The work of Rainey, Ord, and Carter shows that certain salts in the presence of a colloid material, such as gum or albumin, do not form crystals, but certain bodies which Carter calls submorphous, having the peculiarity of adhering not only to adjacent surfaces, but also to each other in laminar series. Such a colloid substance is furnished by the mucus formed in the urinary passages under irritating conditions: through its influence the crystals which exist in the urines of certain individuals modify their form, become spheroidal, and coalesce, giving rise to a concretion which is the starting-point of the stone, the subsequent growth of which is continued in more or less regular concentric layers according to the law of molecular coalescence referred to above.

The chemical nature of the layers varies, and is largely determined by the character and chemical reaction of the urine, which changes from time to time, at one time being acid, at another alkaline. Owing to this alternation of layers a laminated appearance is often presented upon section of a stone: a section will show, for example, a layer of uric acid, then of urates, then of phosphates, the latter being deposited under the influence of the alkaline decomposition of the urine in the bladder; if the urine becomes clear and acid again, as it often does, especially in the earlier stages of the malady, another layer of uric acid will be formed outside of the phosphatic one. Figs. 116 and 117, from Ultzmann, illustrate these formations well.

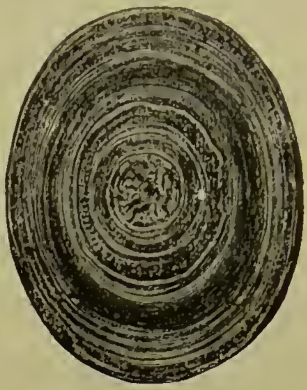


Fig. 116.—Laminated appearance of stone from the deposit of alternate layers (Ultzmann).

One plausible explanation of these periodic returns of the bladder to a healthier condition with the accompanying changes in the urine is to be found in the fact that the phosphatic layer deposited while the urine is alkaline is smoother than the one previously formed, and therefore less irritating to the mucous membrane.

This alternation of chemically different layers is also due to the periodic changes in the urinary salts that are commonly observed. In the writer's experience the most frequent change is that from oxalate of lime to the

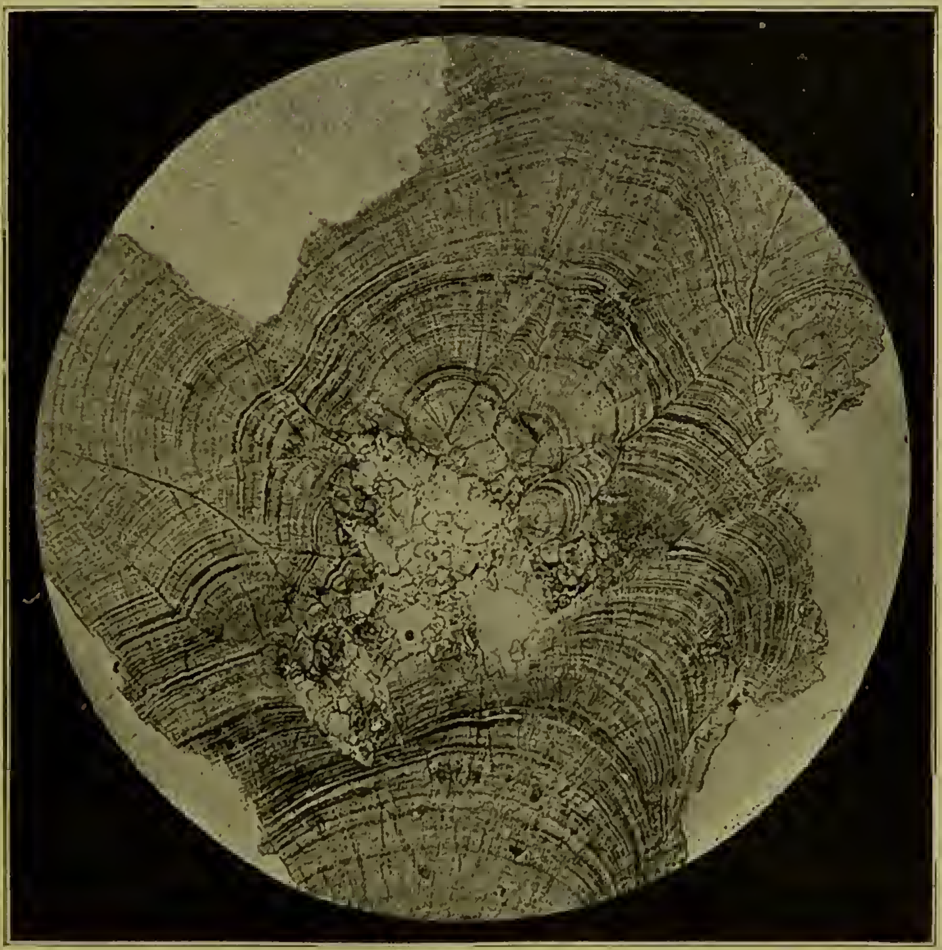


Fig. 117.—Finely-laminated stone of oxalate of lime (Ultzmann).

amorphous phosphates and back again: this particular form of phosphatic deposit is that which, when it is persistent and excessive, is one of the more conspicuous symptoms of the condition to which the name of phosphaturia has been given. In this disease the urine is already neutral or alkaline when secreted in the kidneys. The condition is quite distinct from that of the alkaline decomposition of the urine in the bladder, which is due to local causes, and in which the large clear crystals of the ammonio-magnesic or triple phosphates are seen.

Stones may be classified, according to the salts predominating in their composition, as follows:

(1) Uric acid and acid urates;
(2) Oxalate of lime;
(3) Phosphatic;
(4) Cystine.

Stones of indigo, urostealith, and xanthin have been reported, but are of the greatest rarity. The relative frequency of different stones in Sir Henry Thompson's collection is as follows:

Stones from Male Adults.

Uric acid	551
Uric acid and phosphate	92
Oxalate	34
Oxalate and urate	35
Oxalate and phosphate	15
Phosphates	244
Cystine	3
Total	975

Calculi from Fourteen Female Patients.

Uric acid	10
Uric acid and phosphate	2
Phosphate	2
Total	14

From Male Children.

Uric acid	10
Urate and phosphate	3
Oxalate	2
Phosphate	1
Total	16

The conditions of the bladder which favor formation of stone are—inability of the bladder to empty itself wholly, of which the most common example is that seen in connection with prostatic hypertrophy: here the lower part of the viscus is also frequently depressed into the pouch-like form known as the *bas fond*, containing a greater or less quantity of stagnant urine, called the residual urine, which is particularly prone to undergo alkaline fermentation; and in this medium the phosphatic salts, especially the crystals of the triple phosphates, are readily precipitated, and, being caught in mucus, form the nucleus of the stone, sometimes very rapidly, the character of the stone as it increases in size depending, as has already been described, upon the subsequent alternations of the urine from alkaline to acid reaction, or to its remaining, which is often the case, continuously alkaline. The amorphous phosphates do not form stone in the bladder so often or so rapidly as the triple phosphates do, perhaps because of their less sharp and more rounded form and smaller size. The variation in the propensity of different bladders to form stone is very great, even under local conditions that seem very similar: of two elderly men, for example, with chronic cystitis, and alkaline urines containing precipitates of the triple phosphates, one will form stone in a few weeks; the other will go on for years without doing so. The same is true of other crystalline precipitates: this is not because of the failure of the crystals to be precipitated in the bladder, in many instances at any rate, for the author has carefully verified this statement in a considerable number of cases.

Another condition of the bladder which gives rise to encysted stone sometimes is that of diverticula: these may be said, in some of the more extreme examples, to form separate miniature bladders, in which the conditions are favorable to urinary stagnation and decomposition, and consequently to the formation of stone, which in this case is shut off from the main chamber of the bladder, and is often almost entirely covered over with the inner lining of the bladder-wall, and so often escapes detection by the sound.

Nuclei.—According to Keyes, 90 per cent. of all stones have uric-acid nuclei; of the remaining 10 per cent., foreign substances, phosphatic concretions or oxalate of lime, and blood-clots form the nuclei. If it is true that such uric-acid nuclei are formed in the kidney, it would make the proportion of stones of primary renal origin larger than Ultzmann and others consider it to be.

Foreign substances of the greatest variety have been found as the nuclei of stones: they are frequently introduced into the urethra by people of perverted sexual feeling, especially by women. Bullets, bits of catheters, of pencils, etc. have been noted. Harrison reports the case of a man in whose bladder the mouth-piece of a pipe was discovered, the patient declaring that he had swallowed it by the mouth some time before; and there are other instances in the literature in which foreign bodies have entered the bladder from the bowel by a process of ulceration. The accompanying figures are examples of some of the extraneous substances which have made the nuclei for vesical calculi (Figs. 118–123).

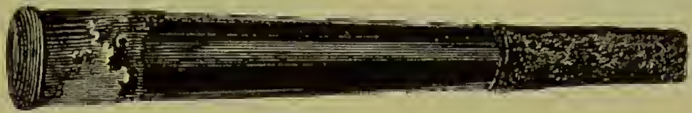


FIG. 118.—Mouth-piece of a pipe found in the bladder of a man (Harrison).

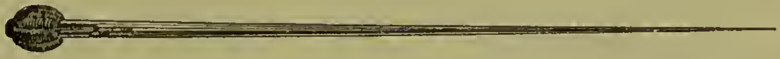


FIG. 119.—Needle armed with a knob of sealing-wax (Harrison).

Consistency, Shape, External Appearance, etc.—The oxalate-of-lime calculus is the hardest, often dark in color, varying from gray to almost black, of more or less spherical form; the external surface is often studded with nodules (Fig. 124), whence it derives its name of mulberry calculus. Occasionally the surface presents numerous sharp projections resembling minute arrow-heads.

The *pure uric-acid stones* are the softest, are yellow, red, or brown in color, and generally present a smooth surface.

Phosphate and *urate stones* stand between the first and second in consistency; the former in color vary from gray to white; the latter are yellowish or reddish.

The Form.—When solitary and freely movable in the bladder the form of stones is characteristic, varying from round to oval; it is determined also by its chemical composition: a pure urate stone has usually a long oval, the pure oxalate a more spherical shape, while a mixed stone of urates and oxalates will incline to the form characteristic of the predominating crystals. The form of stone is modified also by certain local conditions: multiple stones, for example, are facetted; stones lying in diverticula take very curious shapes.

A long, oval stone with an oxalate surface will always be found to have a large nucleus of uric acid or urates, while one which is spherical will have no such nucleus or a very small one. Stones composed wholly of triple phosphates or amorphous phosphates have the form of a long oval, like that of the pure urates, but they are rare; ordinarily, stones with an outer layer of phosphates have large nuclei of urates or oxalates and have no specially characteristic form.

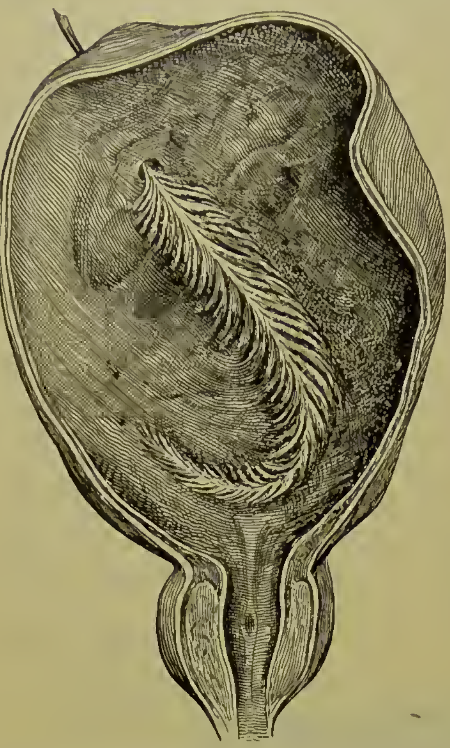


FIG. 120.—Spikelet of meadow foxtail covered with phosphatic deposit (Harrison).

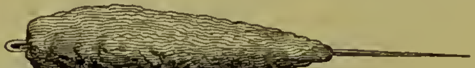


FIG. 121.—Needle more than half covered with a deposit of lithic acid (Harrison).

Spontaneous Fracture of Stone.—The subject of spontaneous fracture of stone has been treated by few writers (Ord, Debout d'Estrées, Fenwick, etc.). This phenomenon is of rare occurrence. It has happened to the writer to meet with two examples of it: in both instances the specimens were found post-mortem. The first observation was published some years ago. In that case the patient, who was eighty years of age, had had no bladder-symptoms up to the time of his death. The bladder contained fifty-nine stones of pure uric acid of about the size of large peas, and a considerable quantity of stone detritus; the larger fragments had all undergone spontaneous fracture in one

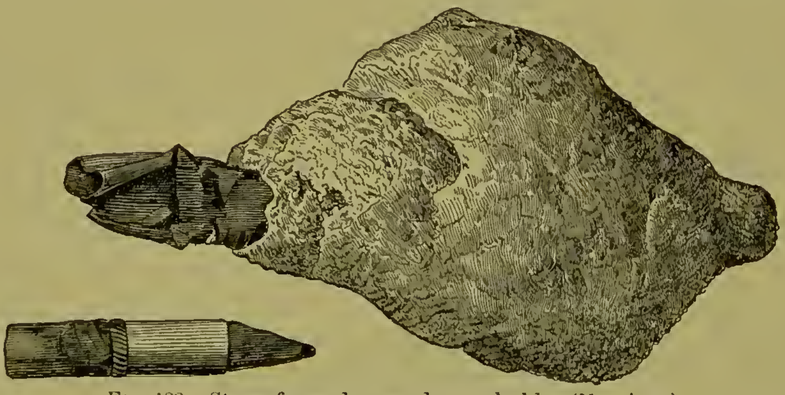


FIG. 122.—Stone formed around a penholder (Harrison).

or both of two ways—either by radial cleavage from the center to the periphery or by splitting in concentric laminæ. (See Plate 6.) The second case was that of a gentleman who had suffered for many years from stone. At the autopsy the bladder was found to contain six stones, four of which were large; five of the stones lay free in the bladder, their surfaces smooth and facetted; the sixth (Fig. 125) was held in a diverticulum near the summit of the bladder: its smaller portion, projecting into the bladder (*a*, Fig. 125), was facetted in the same manner as the other stones; the portion lying in the diverticulum (*b*, Fig. 125), which was that part of the stone spontaneously fractured, about the size of a pigeon's egg, was broken into three fragments (*c*, *d*, *e*, Fig. 126) which could be so accurately fitted together as to leave no doubt that they originally constituted that part of the stone. The dark lines on the oval end (*b*, Fig. 125) indicate the lines of division between the fragments; the fragments are here glued together in order to show the original form of the stone before it was fractured.

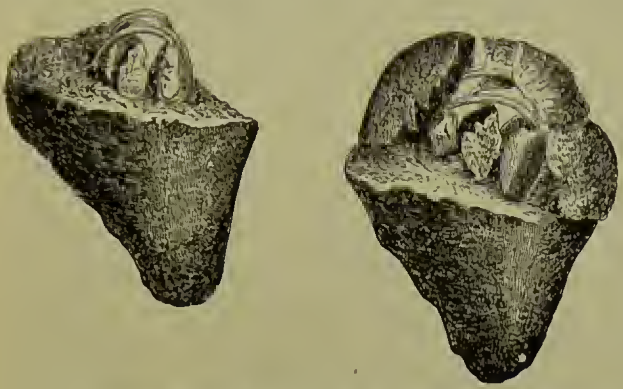


FIG. 123.—Stone formed about a bit of bougie as a nucleus (Debout d'Estrées).

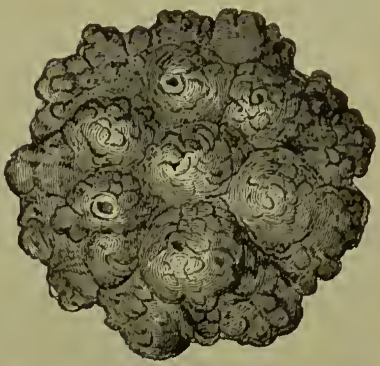


FIG. 124.—Mulberry calculus (Ultzmann).

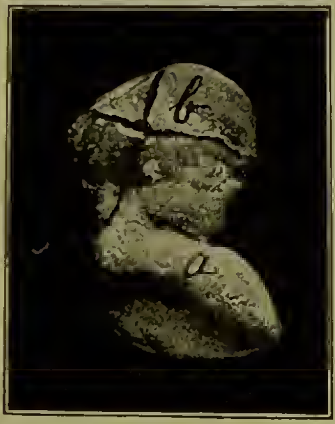


FIG. 125.—Watson's case of spontaneous fracture of vesical calculi.

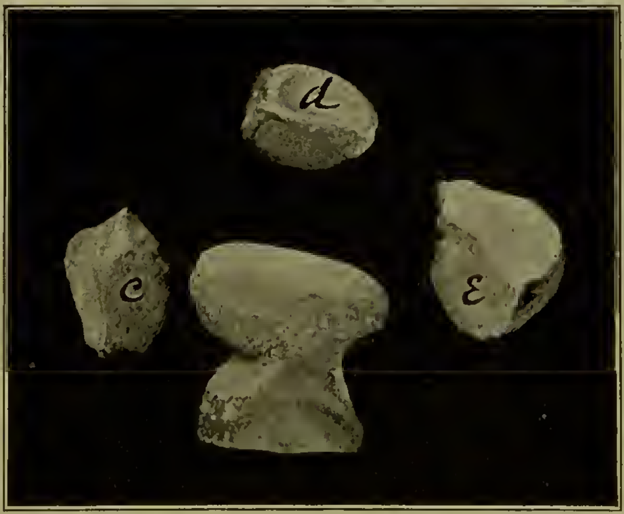


FIG. 126.—Watson's case of spontaneous fracture of vesical calculi.

The two theories advanced to explain the occurrence of spontaneous fracture are those of mechanical force and of chemical action. The writer's second case shows that the fracture may take place in the absence of the first of these agents, since the fracture was located in that part of the stone which lay within the diverticulum, and was consequently protected from any mechanical force capable of producing it, while that part which projected into the cavity of the viscus and was subjected to such force was not fractured. The two parts of the stone have the same chemical composition. The patient had never introduced anything but a soft-rubber catheter into the bladder.

The work of Ord and Rainey, already quoted, suggests an explanation of the phenomenon of spontaneous fracture. They found that spheres of carbonate of lime which had formed in solutions of gum, split radially and disintegrated if placed in a solution of different specific gravity. This suggests that urinary calculi may split similarly under the influence of varying specific gravities and reaction of the urine. It is probable that the colloid framework in which the stone is formed swells by imbibition and thus causes the fracture. Dr. Debout d'Estrées of Contrexeville has seen several examples of spontaneous fracture of stone in patients who were undergoing the treatment at the springs: the sudden influence of the alkaline waters in these cases may be taken as an indication in support of the same theory as that offered by Ord.

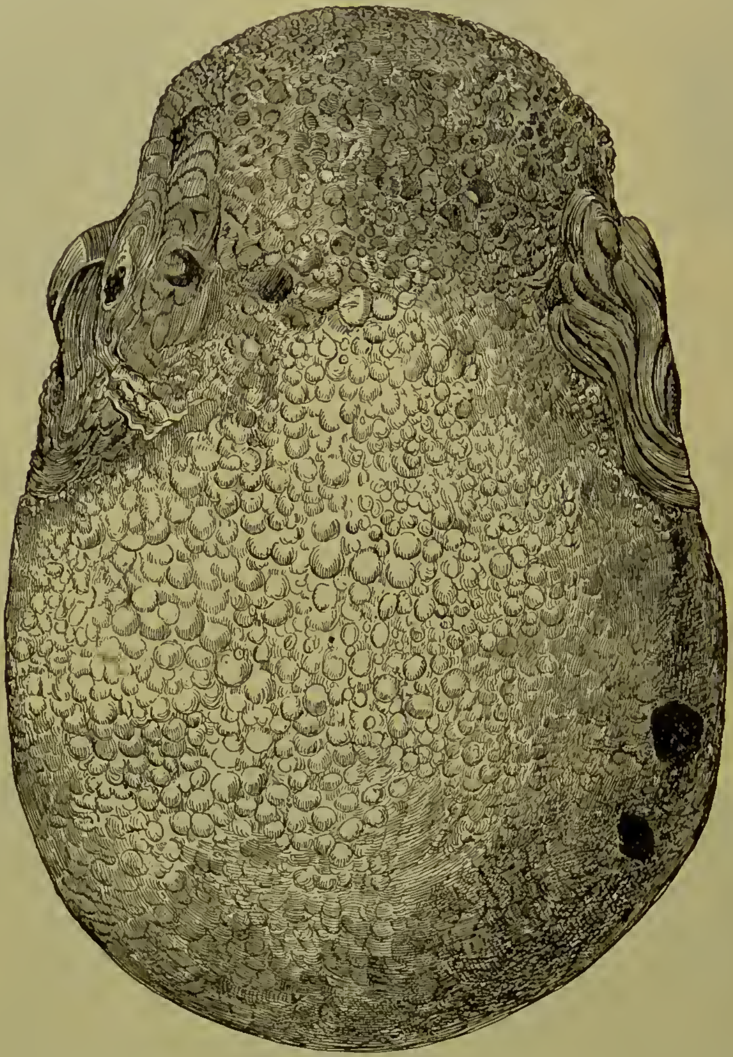
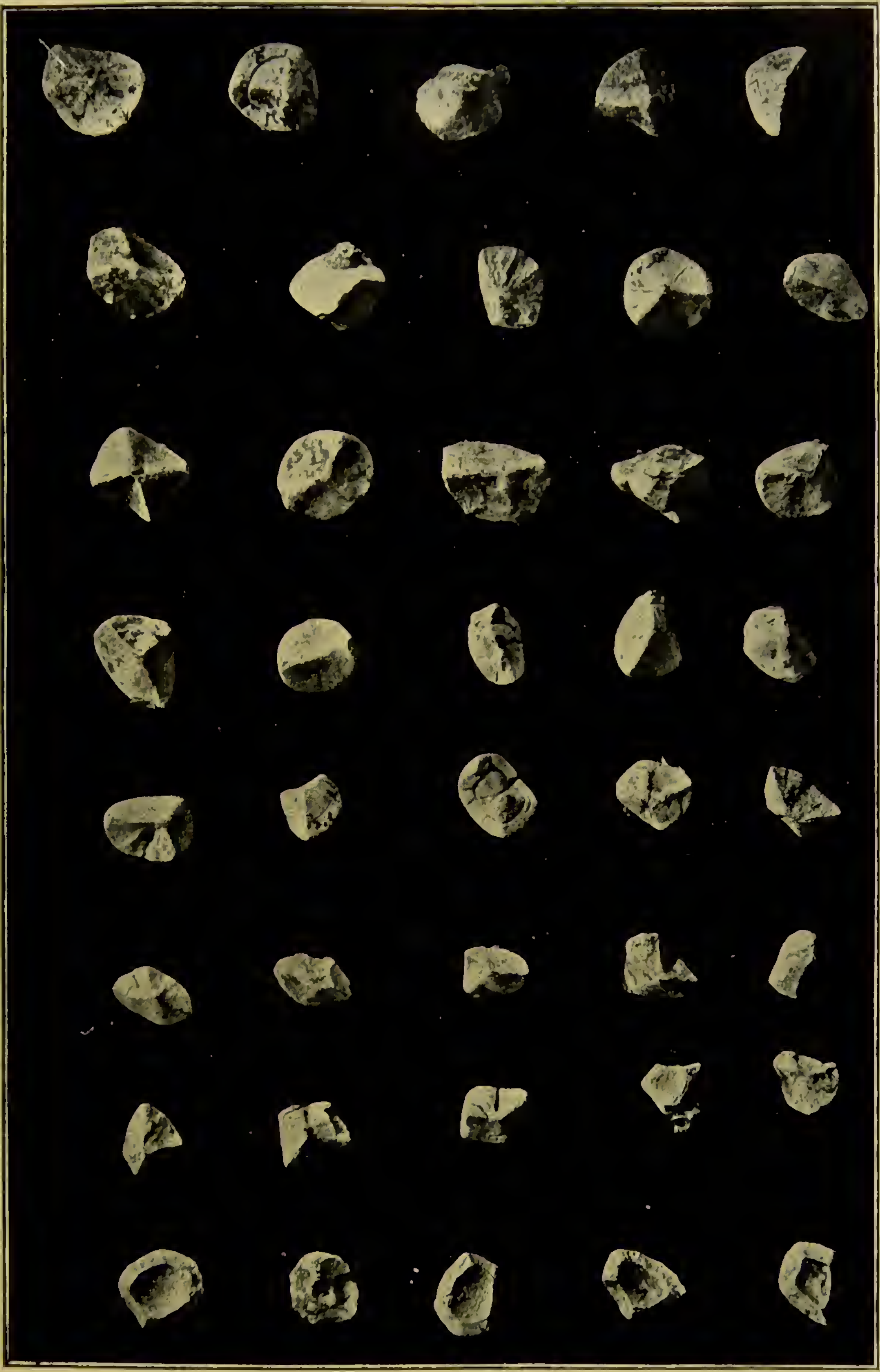


FIG. 127.—Stone weighing fourteen ounces, removed by Sir Henry Thompson.

Number and Size.—Stones usually occur singly, but large numbers are sometimes found. Multiple calculi generally originate in the kidney, and,

PLATE 6.



Fragments of spontaneously fractured calculi from the bladder.

passing into the bladder, constitute the nuclei of separate stones. There are rarely more than five or six stones found, but cases have been reported in which three or four hundred small calculi have been met with. Cabot[1] reports an interesting observation of a patient of his from whose bladder he washed out repeatedly, at short intervals, a large number of small calculi of curious form.

In size there is great variation. Sir Henry Thompson in the *Lancet* of July, 1885, reports 4 cases of large stones removed by him by the high operation, and gives a tables of 5 additional ones of remarkable size removed by operation in England. The weights of the four stones removed by Sir Henry are as follows: 1, Nearly 3 ounces; 2, 1½ ounces; 3, 14 ounces (Fig. 127); 4, 1½ ounces.

Sir Henry refers in the same communication to a uric-acid stone in St. Thomas's Hospital Museum which was removed from the bladder of Sir Thomas Adams, post-mortem, in 1672, as the largest he had ever seen of that nature; also to a phosphatic mass of 46 ounces removed post-mortem, after an unsuccessful attempt to do so during life, from the bladder of Sir Walter Ogilvie. Milton reports as the largest stone ever removed successfully one weighing 34½ ounces, which he succeeded in extracting by a laparotomy and suprapubic cystotomy, the bladder being opened by an extensive incision through its peritoneal investment.

The following table contains 19 examples of stones weighing more than 12 ounces:

		Ounces.		
1.	Preston	51		
2.	Cline	46	Operation.	Death.
3.	Earle	44		
4.	Uytterhœven	40	"	"
5.	Verduc	39		
6.	Milton	34½	"	Recovery.
7.	Despres	32	"	Death.
8.	Deguise	31	"	"
9.	St. Thomas's Hospital	25		
10.	Vitellius	22	"	"
11.	Fattor	20		
12.	Dunlap	20	"	Recovery.
13.	Multanowski	18	"	"
14.	Cheselden	17	"	Death.
15.	Astley Cooper	16	"	"
16.	Harmer	15	"	Recovery.
17.	Thompson	14	"	"
18.	Mayo	14	"	"
19.	Dalrymple	13	"	Death.

Causation.—Of the two conditions which contribute to the formation of stone in the bladder, the first—viz. local conditions in the urinary tract—has been dealt with under the heading of "Formation." The second concerns certain general states of the body which may be included under the name of diatheses. Of these gout and rheumatism are the most frequent, the most important, and the best defined. The other general etiological factors besides these are the influence of race, dwelling, locality, diet, and habits of living.

The negro of the United States is said to be almost exempt from stone, while the natives of certain parts of India and Egypt are very prone to it. In the eastern part of this country stone is comparatively rare, while it is much more common in Ohio, Kentucky, Tennessee, and Alabama.

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[1] *Op. cit.*

The assertion that the prevalence of stone in certain localities is due to the presence of large quantities of lime salts in the drinking-water is not borne out, because of the equally marked absence of the disease in other parts of the same districts which are supplied with the same water; moreover, calculous disease is met with in places which have no such waters at all. Any pure water, like distilled water, for example, tends to increase the quantity of urine, to cleanse the urinary passages of mucus, and to keep the urinary salts in solution; to this extent, therefore, drinking-water exercises a certain influence in the prevention of stone in the localities in which such water exists.

Heredity plays a certain rôle in calculous disease, and there are numerous examples of families in which successive generations have been afflicted with it.

The influence of *climate* seems to be entirely indeterminate, since we find stone to be prevalent among people living under the most varying climatic conditions.

Diet.—There is a general agreement that diet has a very decided effect in promoting or diminishing the tendency of individuals to form stone; thus the excessive, and in some individuals the moderate, use of wines and liquors, especially the fermented or much sweetened ones, and also a diet containing a large proportion of nitrogenous food, favor stone-formation. This is particularly true of those who lead a sedentary life. With a certain proportion of people this combination is productive of gout, one of the many manifestations of which disease is the appearance in the urine of a large quantity of uric acid or the urates. If under these conditions the urine becomes sufficiently concentrated or the amount of uric acid is excessive, a precipitation of its crystals may take place within the urinary passages, and the irritation due to their presence, producing the colloid material already referred to as the medium in which calculus forms, we thus have the two most important factors favoring stone formation.

Cadge has pointed out that in Norfolk, where stone is common amongst the children of the poor, there is great deficiency of good milk, and attributes an important part in the frequent occurrence of stone cases there to this fact. Harrison, quoting Plowright, lays stress on the rôle played by the presence or absence of salt in the dietary in the formation of stone, and draws the following conclusions from a series of observations made with reference to this point:

(*a*) That the presence of salt greatly increases the solubility of uric acid;

(*b*) That salt by increasing the thirst ensures the ingestion of a larger amount of water and a corresponding amount in the increase of urine;

(*c*) That by keeping the colloids equally diffused salt tends to prevent the aggregation of the crystalline salts of the urine into concretions.

Recently Surgeon-captain A. E. Roberts[1] presents some interesting observations upon the geographical distribution of stone in India with reference to the diet: The relative prevalence of the disease is estimated from the records of the operations for stone annually throughout the country, an annual average of the number being calculated from the number occurring in several years, as follows (see table on p. 419):

"1. In British India, then, every year no less than 3041 calculi are removed from the bladders of the natives, or, rather, 3041 operations for the removal of as many (and more) stones are performed, and of this total nearly one-half occur in the Punjab. 2. The next point to note is that the

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[1] *Lancet*, Feb. 9, 1895, p. 31.

Area.	Proportion of population eating rice.	Rates of calculus operations per mille of population.	Population in millions.	Average annual operations.	Remarks.
1. Punjab	$\frac{1}{19}$	0.078	19	1482	
2. N. W. P. and Oudh . .	$\frac{1}{11}$	0.021	45	925	
3. Bombay	$\frac{1}{8}$	0.017	$16\frac{1}{2}$	283	
4. Central Provinces . .	$\frac{1}{3}$	0.011	$9\frac{3}{4}$	112	
5. Bengal Proper	$\frac{2}{3}$	0.0034	$69\frac{1}{2}$	218	Numbers raised by Behar.
6. Madras	$\frac{1}{3}$	0.00067	31	21	
7. Assam	$\frac{3}{4}$	Nil	$4\frac{3}{4}$	Nil	None known.

Total annual average operations for India, 3041.

order of calculus prevalence is in inverse ratio to the population eating rice as its staple food upon each area. 3. Where practically the whole population lives on rice as its staple food calculus disappears, as in Assam. 4. As we leave the coast-areas and mount ever higher above the sea-level toward the interior calculus increases in its prevalence. Though Bombay stands third on the list, its coast-area is very limited, the rice-eating population is small, and the calculus-rate represents the high-lying millet region of the Deccan. We place a double contrast in view in the above sketch—a contrast between the sea-coast and the interior. What we here set ourselves to show is that vesical calculus in India follows as a result of the factors involved in this double contrast. A very interesting battle-drama is constantly going on in the upper layers of the soil—a fight between carbonic and silicic acids for the possession of the bases sodium and potassium—and the result is that the sea accumulates all the sodic chloride, while the soil inland is robbed of this salt and contains little else than potassium salts (Bunge). Now the amount of NaCl in any organism corresponds and varies with the amount in the environment. 1. Inland populations are, to a certain extent, battling with an unfavorable environment as regards the absence of the necessary salt in which they originally developed: this also serves to explain the unconquerable desire which the great majority of people exhibit for salt in their food. 2. It explains the necessity for a liberal allowance of salt to children, our 'embryological ancestors,' if we may so call them, and the consequence of its deprivation will be the more apparent in pathological effects. The offices which common salt performs include—(*a*) the construction of organs; (*b*) it is the chief factor in the formation of gastric juice; (*c*) it dissolves 'globulins;' (*d*) the nitrogenous products of metabolism cannot be eliminated by the kidneys in the absence of chlorides.

"The people who take salt, though differing in every other respect, are all characterized by a vegetable diet. In the same way, those who do not use any salt at all are all alike in taking purely animal food. We have also seen that this urgent necessity for salt in a vegetable diet depends upon the eliminating action of the excess of potash salts, and if various food-stuffs are compared in respect of this potash constituent, it will be found that the proportion of potassium to sodium is highest in the very food-staples on which the vast bulk of the Indian population is supported—that is to say, highest in all the common Indian food-stuffs save rice.

"Now, the most important Indian diet-stuffs—*i. e.* the cereals and leguminosæ, not rice—yield urine which is as acid as that due to a meat diet under normal conditions of digestion, because they are rich in albumin and phosphates and in calculus. The evil factors are, as we have shown, (1) the great amount of albumin, and (2) the poverty of bases (due in great extent to deficiency of the common salt necessary), which are able to neutralize the uric and sulphuric acids formed from albumin.

"One more point as regards the liability of children to calculus: The amount of kidney excretion per kilogram of body-weight is far greater in children than in adults. Parker[1] gives the following statement:

	In children.	In male adults.	Excess in children per kilogram.
Water	59 c.c.	23 c.c.	36 c.c.
Urea	0.973 gram.	0.500 gram.	0.473 gram.
Urea and volatile salt	0.279 "	0.151 "	0.128 "
Chlorine	0.308 "	0.106 "	0.202 "

Hence in children the amount of chlorine is three times greater than in adults (note also the excess of nitrogenous products), and hence the special necessity of extra NaCl and the special liability to concretions in children. Again, NaCl acts as an absorbent, not only of crystalloids, but of colloids, fibrin, mucin, and albumin. Bence Jones first showed the solvent action of NaCl on urate of ammonium; and this is also the case with uric acid: 1 part of uric acid requires 8000 parts of water to dissolve at the body-temperature, whereas the addition of $\frac{1}{2}$ per cent. of NaCl doubles its solubility, and 2 per cent. of NaCl quadruples its solubility (Plowright).

"Perfectly healthy urine should show no appreciable deposit: when it becomes concentrated (as it is liable to do in natives, for reasons given), uric acid is thrown down as a urate. This may occur within the bladder, and the presence of a solid body in any part of the urinary tract favors deposition greatly. Dr. Goodhart has put it on record that the specially farinaceous feeders among children are those addicted to passing uric acid in abundance. Lastly, Hirsch, in his great work, *Geographical and Historical Pathology*, remarks on the mystery of the excessive prevalence of stone in the tropics, while gout is practically unknown. Now, Dr. Haig—to whom I return thanks for much kindly personal help—has shown that the excretion of uric acid is greatly influenced by the comparative alkalinity or acidity of the blood, and that the amount of acidity may be made to vary within very considerable limits by the kind of food and by the process of digestion (as we have seen), as well as by the use of drugs. Uric acid in an acid blood tends to get stored in the spleen and joints, but when the blood is rendered alkaline (as we have seen it by deficiency of NaCl and excess of K), uric acid is dissolved out and excreted. We have, then, (1) greater tendency to formation of uric acid in natives, with excess of albuminates and their deficient metabolisms; and (2) very complete elimination of this uric acid by alkaline blood (due primarily to deficiency of common salt) as far as the bladder. The obvious result is that gout must be a very rare disease among the natives, because the alkaline blood-stream never permits storage of the uric acid in the system or the joints. Sir W. Roberts draws attention to the effect of sleep and long daily fasts in increasing the amount of uric acid excreted; and these are assuredly factors in far greater play among natives in India, with their fast from evening to mid-day and their somnolent habits, than in Europe. The very common affection of enlarged spleen is another factor in the excessive excretion of uric acid. Pettenkofer found the normal average to be 0.872, while in the case of enlarged spleen it rose to 1.424 parts in 1000. A case of a boy of sixteen years of age is recorded who excreted 18.28 grains daily, while his normal average should be about 6 grains. We have, then, perhaps an excessive production of uric acid by the factors at work just described, and certainly far more complete elimination of it from the body and tissues by the alkaline blood-stream as far as the bladder. What, then, causes its deposition here? I do not think we can at present detail with certainty the steps in the process, which are doubtless varying and complicated. One important factor, perhaps, is the neutralization of the acid sodium phosphate (the uric-acid solvent) by the aromatic sulphates; and we know that the alkaline bases are diminished which go to neutralize the sulphuric and uric acids. My chief object to-day has been to draw attention to some important dietetic considerations underlying calculus-formation in India. More intimate and sustained observation of the chemistry of the excreta may perhaps avail to clear up doubtful points and piece together the scattered fragments of our little knowledge, and I hope in a fuller paper to throw some light on this important problem."

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[1] *Physiological and Pathological Chemistry.*

In the condition known as phosphaturia the salts are precipitated in an amorphous form as a fine powder. This manifestation is associated with anemia, with certain functional diseases of the brain and spinal cord, sexual excess, overwork of the brain. The author has observed two or three examples of temporary phosphaturia lasting from three to eight weeks, recurring invariably during times of hard study while preparing for examinations, in individuals in whom the phenomenon was never observed at any other time.

In true phosphaturia the urine is alkaline when formed in the kidney; this, rather than an increase in the quantity of the phosphates, is the essential feature of this condition. The alkalinity is due to the fixed alkalies and not to ammonia, which is absent.

Ultzmann[1] states that it is due to carbonate of sodium or to carbonates or phosphates of lime and magnesia. The phosphate of lime is generally amorphous, or else has the form of beautiful translucent rosettes composed of minute needle-like crystals: these needles appear also singly or in pairs crossed at an obtuse angle, and resembling a pair of rapiers; the carbonate of lime appears as a white amorphous substance or else in mulberry-like groups of minute highly refracting crystals.

The distinctly crystalline forms appear only in such urines as are made artificially alkaline by fixed alkalies, such as are produced, for example, by the ingestion of certain mineral waters in large quantities or by long-continued vegetable diet.

In a subject having a true phosphatic diathesis the phosphates appear in the urine in spite of an almost exclusive diet of animal food, and generally have the form of the amorphous phosphates and carbonates of lime. The appearance of the phosphatic sediment is very capricious, coming and going from day to day and oftentimes in the same day.

The sediment may be present for a very long time without giving rise to stone-formation. The bladder is generally rendered very irritable by the presence of the sediment.

Oxaluria.—Much contradictory evidence is offered as to whether oxalic acid exists in the normal urine or not. Ultzmann[2] thinks that it does not, or at most in very small quantities, and that it never appears in combination with the lime salt as oxalate of lime in the normal urine: if such crystals are found in the urinary sediment in large quantities and persistently, they constitute a pathological condition called oxaluria or the oxalic-acid diathesis.

The author's observations coincide with this view, and he has always seen a well-defined group of symptoms associated with the presence of oxalate-of-lime crystals if the latter are abundant and persistent, and the subsidence of these symptoms as constantly accompanying the disappearance of the crystals.

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[1] *Op. cit.*

[2] *Op. cit.*

Whether oxaluria is simply a manifestation of certain general disorders, or, on the contrary, the group of symptoms referred to results from oxalic-poisoning, is not determined; both views are held.

Oxaluria occurs most frequently among poor and ill-nourished people, but it is met with in all classes, and is often persistent under the best conditions of living and treatment. Damp dwellings and low-lying districts are said to favor its production. Cases observed by the anthor, which have been numerous, have been almost all amongst people living in the best hygenic conditions, and he has met but very few of them amongst hospital patients. Oxaluria may be artificially produced by the ingestion of articles of food which contain it, such as tomatoes, sorrel, and certain fruits.

Oxalate of lime appears in the urine in the form of large and small octahedral crystals; the latter are frequently gathered together into small concretions, and are difficult to recognize as octahedrons because of their minute size. These crystals are highly refracting. The small octahedrons are thought by some to indicate that they have been formed within the urinary passages, while the large ones are thought to be formed only after the evacuation of the urine.

More rarely the crystals take the forms of dumbbells, of ovoid disks, and occasionally of long quadrates.

Cystinuria.—In rare cases cystine crystals are seen in the urine. They have the form of hexagonal plates and are colorless. Stone forms very rapidly from these crystals. Its rarity is seen from the following quotations: Beneke in 649 vesical calculi found 3 of cystine; Ivanchich found 1 cystine stone in 300; Ultzmann states that in such urines uric acid exists in very small quantities or not at all.

The length of time during which a patient may have deposited a crystalline sediment in the urine while it is within the urinary passages, before stone is formed, varies greatly, and chiefly in accordance with the conditions of the bladder which favor or are unfavorable to stone-formation, as has already been described under the heading of "Formation."

Age.—With regard to age Sir Henry Thompson's statements are of much interest. The following are taken from his introduction to the *Catalogue of the Collection of Calculi in the Bladder* (1893), which represents his total experience in the removal of vesical calculi from the first case in 1857 up to April, 1893, the number being 1007. He remarks upon the relative frequency and the relative rarity of calculous disease in children as compared with its prevalence in later life. It is usually asserted that stone occurs most frequently at the two extremes of life, bnt, as Sir Henry points out, this inference was drawn from tables of operation and collections of calculi made during the earlier part of the century, before the frequency of stone in elderly men was recognized, and when it was frequently overlooked; and therefore the conclusions are erroneous. He considers that the largest proportion of cases in male adults occurs between the ages of fifty and seventy—that it is rarest between the ages of fifteen and twenty-five.

In the eighth edition of his clinical lectures on *Diseases of the Urinary Organs* (1888) he dwells upon the rarity of stone in children of well-to-do families, and its relative frequency in those of the poor, as will be seen in the table below, which includes the total number of his patients under sixteen years of age up to 1893. There are but 16 of these, and but 3 of these were private patients. He quotes Sir William Ferguson as having told him that in his entire experience he never received but one fee for operating upon a child for stone in the bladder. As Sir Henry says, rich people who are self-indulgent, who take but little exercise, and eat and drink largely are those who late in life are prone to stone, but the children of these people rarely have it, while with the poor and ill-nourished the reverse is true. The following table from Sir Henry Thompson's catalogue shows age with reference to frequency of stone:

	Below 16 years.	16 to 24 years.	25 to 50 years.	51 to 70 years.	Above 70 years.	Total.
In the hospital	13	5	22	56	4	100
In private	3	8	93	583	206	893
Total	16	13	115	639	210	993

Symptoms and Diagnosis.—The two cardinal symptoms of stone in the bladder are pain and hematuria.

Pain is a very constant symptom. For a variable period it is usually preceded by bladder irritability, which expresses itself by increased frequency of urination; this is most marked during the daytime while the patient is moving about, and serves to distinguish it from the same symptom arising from prostatic hypertrophy, in which it is most conspicuous during the night. This sort of bladder irritability is not always to be distinguished from that arising from the presence of the crystals of the various urinary salts previous to the actual formation of stone. *Reflex* bladder irritability is frequently due to the presence of calculus in the kidney, and it is a common error to overlook the renal condition and to attribute the symptom to the bladder itself in these cases. It is also true that the urine may be normal with a stone in the kidney for considerable periods of time; this the writer has observed in 5 cases. On the other hand, there may be no pain or bladder irritability when there is a stone in the bladder; this fact is especially noticeable in some cases of stone in connection with prostatic hypertrophy, in which a stone with a smooth surface becomes lodged behind the jutting intravesical portions of the enlarged gland in a deep *bas fond*, and is not pushed against the sensitive vesical neck as the urine flows out of the bladder. Stones which are retained in diverticula are sometimes painless also.

The two characteristic features of the pain due to stone are—that its greatest intensity is at the end of the act of urination, as the stone is grasped by the bladder and pushed against the sensitive vesical orifice, and that it is increased by exercise and motion, especially such as jolting over a rough road or riding. The degree of pain varies greatly, but is often intense. It is most severe in children and young people: one often sees the patient shrink from urinating, whimpering as the urine begins to flow, and uttering loud cries as the stream comes to an end.

The character of the pain from stone is that of an intensified desire to urinate: it is usually most marked at the head of the penis and along the urethra; sometimes it takes the form of a dull ache in the perineum and about the anus, causing straining at stool; at other times it has a more radiating character, shooting down the thighs; it rarely, however, has the extensive radiating, lancinating sensations seen in cases of cancer of the neck of the bladder or of the prostate.

Pain from stone differs from that associated with renal or bladder tuberculosis in that the latter is most pronounced when the bladder is full, and is not so noticeably augmented by exercise.

A small stone with an irregular surface often causes more pain than a much larger one which has the contrary characteristic.

Periods of comparative or entire freedom from pain occur in some instances: they are perhaps due to the changes in the surface of the stone following upon chemical changes in the urine. Thus a period of immunity from pain might succeed one of suffering because of the deposition of a layer of phosphates upon one of oxalate of lime. The condition of the bladder itself has also much to do with the degree of pain experienced: the thin-walled, atonied bladders, for example, suffer much less than those having thick walls and small capacities.

Blood.—Blood is rarely absent from the urine in cases of vesical calculus, though sometimes it appears only microscopically; usually it is in sufficient quantities to tinge the urine pink, and often enough to form clots of considerable size: these have no regular form, such as those which originate in the kidney sometimes have, but are irregular and have the appearance of freshly formed coagula.

Hemorrhage from the bladder in cases of stone is rarely so profuse as that seen in connection with most cases of tumor of the bladder and in occasional examples of prostatic hypertrophy, in which very profuse bleeding may occur from an ulcerated surface of a third lobe rising abruptly in the prostatic urethra that may have been injured in the first instance by the passage of an instrument. The hemorrhage from tuberculous disease is usually less than that from stone, and, as with pain, it is less noticeably increased by exercise. With calculus the blood often appears as a few bright drops at the end of urination, corresponding to the time of greatest pain.

The quantity of blood and the degree of pain are generally determined by the character of the surface and the contour of the stone.

Stoppage of the Stream.—Sudden stoppage of the stream, which is mentioned as a frequent symptom of stone, is, according to Sir Henry Thompson, one of the rarest; it sometimes occurs, and is due to the spasmodic closing of the voluntary muscles of urination when a small stone is forced into the vesical orifice.

Priapism is an occasional symptom.

The Urine.—The urine, besides the usual characteristics of cystitis, presents some significant features which are of service in making the diagnosis. The most important of these is the presence for a greater or less time previous of crystals in the urinary sediment. Cabot has called attention to the significance of the sudden disappearance of a brick-dust sediment that has been present for some time, as indicating the time of actual formation of stone in the bladder.

Ultzmann considers that the presence of the rarer forms of the crystals of oxalate of lime and of uric acid—the dumbbells and long quadrates of the former, and the large, long, sharp-pointed ones of the latter—indicate the danger of immediate formation of stone.

A very suggestive sign of the presence of stone when blood is present in the urine in microscopic quantities only, is its increase after the patient has been moving about through the day, as shown by two examinations, one made in the morning and one at the end of the day.

Cystitis.—The time at which a vesical calculus produces cystitis varies in different cases: the urine may remain clear for a very considerable time after a stone has formed in the bladder; this is particularly true with pure uric-acid stones.

Detection of Stone.—The two conditions most frequently mistaken for stone in the bladder are renal calculus and tubercular disease of the kidneys, bladder, prostate, or seminal vesicles. Examination of the bladder decides the question definitely in almost all cases; and this is conducted in one of the following ways, according to the nature of the individual case:

(1) By sounding; (2) by rectal touch; (3) by the use of the evacuating pump; (4) by digital exploration; (5) by the cystoscope.

The most common way of detecting stone is by sounding, which consists in passing into the bladder through the urethra an instrument of appropriate form—the stone-searcher—the operator seeking to touch the stone with the tip. Various forms of this instrument have been devised. Its essentials are—that it shall have a short beak, permitting easy rotation within the bladder; that the curve of the beak shall have a form that will most readily pass through the deep urethra in cases of prostatic enlargement; and that the shaft should be of a size that permits free rotation in the urethra—No. 16 of the French scale. Such an instrument is that shown in Fig. 128. A smaller searcher should be used for children, one having a caliber of 10 (French scale).

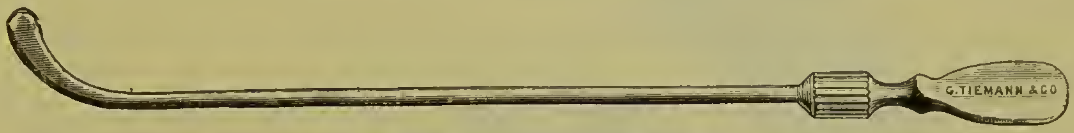

FIG. 128.—Thompson's latest stone-searcher.

Some surgeons prefer to use a searcher made of soft metal, which they can bend into any form they wish to facilitate its passage into the bladder; the soft metal, however, has the disadvantage of giving a less definite sensation to the fingers. Thompson's searcher has a flat handle like that of the urethral steel sound, so that the position of the tip in the bladder can be seen; it has also a corrugated collar which aids in rotating the instrument. Another form is that of a hollow searcher which allows of withdrawal or injection of water through it, so that the amount of fluid in the bladder can be varied without removing the searcher.

A small lithotrite is an excellent searcher: if the stone is seized by it and the instrument is then rotated, the presence of multiple calculi can be determined, the one held in the lithotrite striking against the others as it is moved from side to side. Moreover, if the lithotrite is used as a searcher, the operation can be proceeded with at once if appropriate. An idea of the size of the stone is often correctly obtained also.

In sounding the following precautions should be observed: The patient should be kept quiet during the day on which the sounding is done, and should be confined to bed for, at any rate, twenty-four hours if any of the following conditions are present: viz. cystitis, prostatic hypertrophy, renal disease, or the condition called by Sir Andrew Clark renal inadequacy, by which is meant a state indicated by a fairly well-defined group of symptoms, often seen in old men in connection with prostatic enlargement—viz. thirst, dry, coated tongue, flatulence, and malaise, a low specific gravity being often the only evidence of disease of the kidney furnished by the urine. A lack of these precautions may perhaps result fatally for the patient. The patient should not be examined in the physician's office and then sent away. It is true that no serious consequences will follow in most cases when such a course is pursued, but occasionally the physician will have cause to regret having done it.

The administration of an anesthetic will depend on circumstances. With elderly men, especially with those who have become used to passing a catheter because of prostatic enlargement, and whose urethræ are not sensitive, it will rarely be necessary, whereas with children it is usually better to give it.

The surgeon should be equally able to pass the searcher from either side of the patient. If he stands on the patient's right, the right, which is the most practised hand with most operators, naturally manipulates the instrument. The instrument should be held lightly between the thumb and fore finger and rotated gently from side to side; if there is a deep pouch, such as is present behind the projecting portions of an hypertrophied prostate, the beak of the searcher must be turned completely over in order to explore it; when this is done the shaft should be depressed between the legs of the patient. Small stones in this pouch are frequently overlooked through failure to do this. The stone will be more easily detected under these conditions if the pelvis is raised so as to roll it out of this pouch; it is of equal advantage to keep this position during the operation of lithotrity. This point will be referred to again when speaking of the operation.

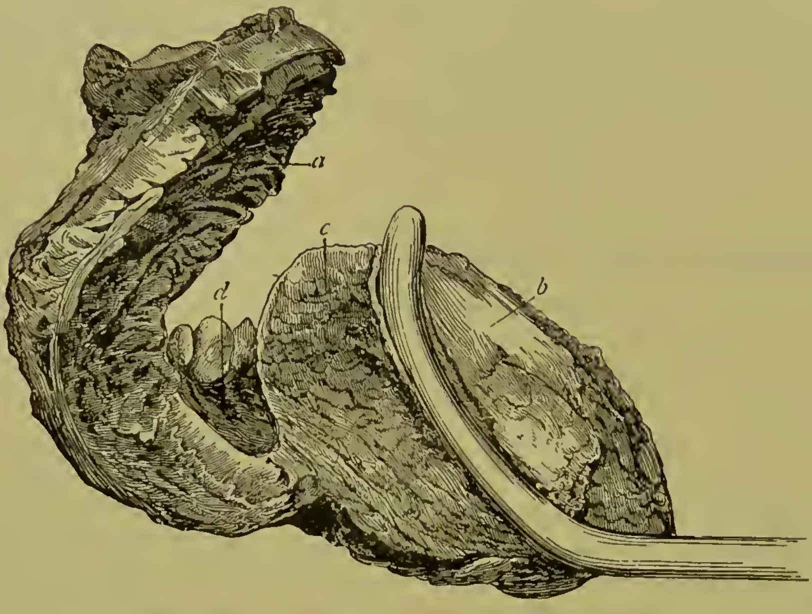

FIG. 129.—A perpendicular section through the bladder, median enlargement of the prostate and elongation of prostatic urethra; *a*, greatly thickened bladder-wall; *b*, left lateral lobe of prostate; *c*, middle prostatic lobe; *d*, bas fond of interior of bladder, with small stone occupying it behind the hypertrophied middle lobe (Watson).

The presence of a stone can be demonstrated to an audience by attaching a bit of thin board having the form of a sounding-board to the end of the staff, thereby increasing the sound of the impact of the tip upon the stone, so that it is easily heard at some distance. A stethoscope may be of service to the surgeon himself.

The bladder when sounding for stone should contain about four to six ounces of fluid: a bladder with small contents is difficult to examine, because the movements of the searcher are restricted, and if the mucous membrane is not made smooth by sufficient distention, a small stone may escape detection by being caught in its folds. If the urine is clear, there is no objection to sounding the bladder with its natural contents, but if a cystitis be present, the bladder should be carefully washed out and injected with a warm boracic-acid solution.

Sources of Error in Sounding.—Stones lying in a deep *bas fond* behind an enlarged prostate that projects prominently into the bladder are frequently not detected by the searcher (Figs. 129 and 130).

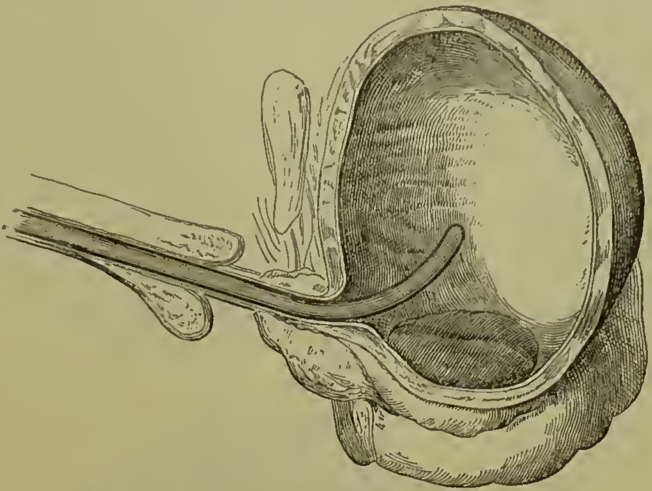

FIG. 130.—Calculus behind prostate (Coulson).

Failure to enter the bladder, the operator believing that he has done so, while in reality the tip of his searcher is being moved about in a capacious and elongated prostatic urethra, such as is sometimes met with in cases of prostatic enlargement, is another reason for the failure to find a stone. This space is in such cases large enough to allow of partial rotary movements of the tip of the instrument, giving the sense to the fingers as if it were moving over the surface of a small, contracted bladder.

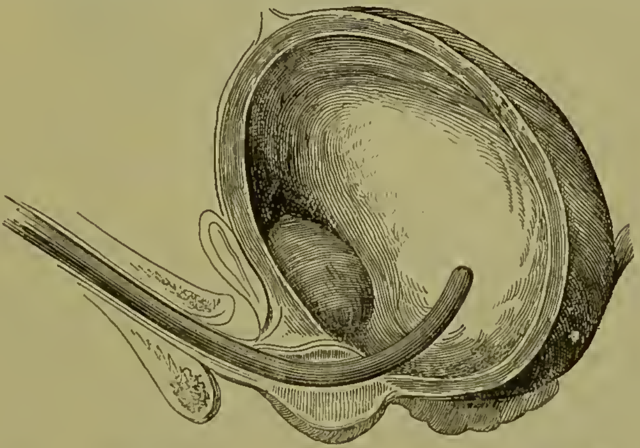

FIG. 131.—Bladder with calculus behind the pubes (Coulson).

Hard, prominent trabeculæ, especially if they are covered with a phosphatic incrustation, give a very deceptive sense, closely resembling that imparted by a stone: in this condition, however, the sound feels as though it were being moved over the surface of the bladder, and there is no feeling of its being in contact with a loose, movable body. The stone may lie behind the symphysis pubis (Fig. 131) and thus escape detection.

A stone is sometimes covered with mucus, and then gives no characteristic touch to the searcher. Encysted stone may be impossible to detect by the searcher (Fig. 132).

An excellent instrument for finding small stones is the evacuating tube. If the tip is placed in the most dependent part of the bladder and a current of water made to circulate by the pump, the stone is brought by the return flow sharply against the tip of the tube, with the characteristic click which is unmistakable: care should be taken to exclude all air from the tube, else the passage of bubbles in it may be mistaken for the touch of a stone. The sucking of the bladder-wall into the mouth of the tube is also likely to be mistaken for stone by novices.

In women and children stone may often be detected by bimanual examination, and it has happened to the writer recently to discover a stone in a man while examining an enlarged prostate by rectum by the sensation of ballottement, the stone being thrown sharply upward by the tip of the fore finger, and received again upon it as it fell to the bottom of the bladder, giving a perfectly characteristic feeling in so doing.

The *cystoscope* is of value in finding encysted stone or stones disguised by a covering of mucus, or very small stones that have escaped detection by the searcher.

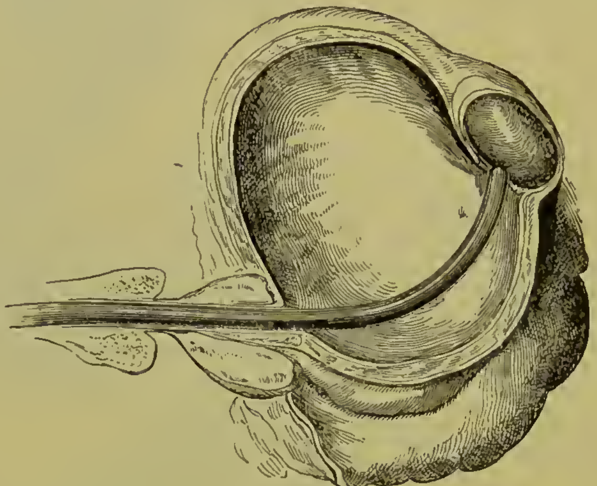

FIG. 132.—Bladder with an encysted calculus (Coulson).

Digital Exploration.—There remains as a final resource digital exploration, as proposed by Sir Henry Thompson, conducted through the male perineum or in women through the dilated urethra, the dilatation being accomplished by the passage of successively increasing-sized metal dilators until the fore finger can be entered; the meatus should be cut previously. In men the posterior urethra is similarly dilated before the finger is inserted. With the tip of the index finger in the bladder the interior of the organ can be explored, and this examination is aided by pressing the fingers of the other hand well down above the symphysis and moving the bladder about with them over the tip of the examining finger; in this way the surface of the organ is made to pass over the finger rather than the latter over it. This examination cannot be properly carried out if the pelvis has a very narrow outlet, if there is ankylosis of the hip-joint, or if there is a great prolongation of the prostatic urethra owing to prostatic hypertrophy.

Suprapubic cystotomy may be substituted for the perineal operation for the purpose of exploration when the above-mentioned obstacles to the successful execution of the latter are present, and when there remains a strong suspicion of the presence of stone. It has the advantage of allowing a more thorough examination, in which the eye aids the sense of touch. When done for this purpose the incision into the bladder should be large enough only to admit the fore finger easily; it may be enlarged afterward if the requirements of the case demand it. It is rarely called for, however.

Treatment.—The treatment of vesical calculus is divided into—(1) General, (2) Local, and (3) Operative. The former includes the preventive and solvent treatment.

Preventive treatment consists in the adoption of the measures which experience has shown to be of value in overcoming the tendency to form crystalline sediments in the urine, which has already been described under the name of Diatheses. This part of the treatment is one of the most vexed questions in medicine, and it still remains a subject of discussion and widely differing opinion, in spite of the practice of innumerable systems, stone-cures, experiments in the chemical and physiological laboratories, mineral springs, etc. etc., upon which many writers base various methods of treatment and give assurances of being able to prevent stone-formation. The author humbly confesses his own inability to secure such fortunate results as are described by them in a certain proportion at least of his own cases which he has submitted to the regimens prescribed, and has sometimes seen stone form in the kidneys or the bladders of patients who have for long periods scrupulously followed the directions given them, and in whom there has, despite all the ingenuity of the writer, continued to be a persistent deposit of a crystalline sediment which has finally resulted in the formation of stone. This fact is mentioned in order that the young practitioner may not be misled into thinking that it is a simple matter to overcome a well-pronounced diathesis, for he will often find it one of the most difficult problems in his experience. This has in this vicinity (Boston) seemed to the writer to be especially true of cases of oxaluria and phosphaturia. It is, on the other hand, undoubtedly true that the preventive measures about to be mentioned prevail against stone-formation in many cases, and the patients who show an inveterate habit of depositing crystalline sediment in the urine while it is still within the urinary tract in spite of intelligent treatment, are fortunately in the minority. The following are examples of the latter class:

Two cases of persistent phosphaturia, of six and eight years' duration respectively, both patients being under observation during almost all the time; both have passed phosphatic masses from the kidneys, and one of them has had already a small vesical calculus. In these cases, as is usual, the amorphous phosphates could generally be kept in solution within the urinary passages by the administration of dilute phosphoric acid, but no method of treatment was of permanent benefit; and the same has been true of 3 cases of oxaluria and 2 of uric-acid diathesis. A noticeable feature with these patients has been the inability to increase the quantities of urine when, as frequently happened, they became scanty. One of the patients with oxaluria and both of those with uric-acid deposits formed vesical calculi. These patients were under observation for from four to nine years, and during these periods were constantly under the preventive treatment of one sort or another that seemed best adapted to their especial conditions. It does not, however, come within the scope of this article to speak at length of the urinary diatheses, so that only the more important points concerning the preventive treatment which involve them will be referred to.

The principal objects sought in the preventive treatment are—to overcome the systemic defective processes of assimilation and tissue-metamorphosis of which the urinary diatheses are one manifestation, to combat the local conditions of the bladder already described which favor stone-formation, and to keep the crystalline deposits in solution while in the urinary passages.

The treatment may accordingly be divided as follows: 1. Dietetic and hygienic measures, including exercise, baths, climate, etc. 2. The treatment of cystitis, emptying the bladder, restoring the caliber of the urethra when required, etc. 3. Diluting the urine and changing its chemical character by drugs and the use of certain mineral waters.

The largest number of cases of stone are of the uric-acid class.

The tendency to form uric-acid deposits in the urine is much more frequent after than before middle life. If it manifests itself decidedly at an earlier period, it usually indicates a strong hereditary influence, and suggests that the patient is likely to suffer from its consequences unless he follows a strict regimen to overcome it and it is correspondingly obstinate in resisting treatment.

Sir Henry Thompson assigns to faulty action of the liver and intestinal tract the chief responsibility in the production of gout, of which the uric-acid diathesis is one manifestation. He does not pretend to explain in precisely what this faulty action consists, but explains the familiar group of symptoms which are its expression as the result of deficient excretory action of the bowels. These symptoms are—headache, nausea, depression, flatulence, acid fermentation of the stomach contents, irritability, neuralgic pains in the back and limbs.

The treatment should be directed to stimulating the secretory function of the primæ viæ without depressing the vital powers. This end is best attained, he thinks, by the prolonged use of certain mineral waters containing a considerable quantity of sulphate of sodium and magnesia. Of these waters he gives preference to Hunyadi Janos and Friedrichshall, taken on rising in the morning in moderate doses and with the addition of hot water. Carlsbad waters should be reserved for robust, plethoric patients and avoided by nervous, delicate ones. The Carlsbad treatment, he thinks, is best carried out at home rather than at the springs, provided the regulations that are enforced at the latter are observed. He condemns the use of diuretic drugs and alkaline medicines administered apart from the mineral waters.

With regard to diet there is a general agreement that the great restriction of animal food formerly recommended is a mistake. The more easily digested meats should be selected, and eaten only roasted or broiled. All canned or preserved meats, fried meats, tongue, ham, veal, pork, turkey, corned beef, smoked beef, and fried, canned, potted, dried, or smoked fish, are to be avoided. Highly-spiced sauces, peppers, salad dressings, fatty foods also should be reduced. Sugar, syrups, and sweets of all kinds are generally held to be especially injurious and should be reduced to a minimum or wholly forbidden;[1] saccharine pellets may be used as a substitute for sugar in tea and coffee. Of fruits, the following may be allowed: peaches, oranges, lemons, grape-fruit, and, unless they disagree with the individual patient, as they sometimes do, melons. Vegetables very rich in sugar are to be avoided, such as beets, for example.

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[1] A recent article in the *Lancet* by Professor Harley of London contains some interesting observations in connection with this question. How is it, he asks, if sugar be so active an agent in the production of gout, that gout is scarcely, if at all, to be found amongst the women of the Eastern harems or the negroes of the South of the United States, both of these classes of people being in the habit of consuming very large quantities of sugar, and the former class leading very sedentary lives? He further cites a few examples of individuals who as an experiment with reference to this subject took sugar in daily-increasing doses for a considerable period of time, until the amount of seventeen ounces per diem was reached, without being able to produce any gouty symptom whatever. Professor Harley considers that the injurious quality in champagne is not sugar but acetic acid, to which he refers the production of gouty symptoms, and states that this acid exists in relatively large amount in the very dry and brut champagnes especially.

The question of drink is even more important than that of food. With few exceptions patients with uric-acid diathesis are better for totally abstaining from all alcoholic drinks. If the patient cannot be persuaded to do this, or if there is any special reason for his taking them, the stimulant should be selected with care and used as sparingly as possible. Generally speaking, the least injurious of the wines or liquors are the good qualities of whiskey or gin; they should be taken with meals and well diluted with water; next to these come the natural, unfortified sherries, which are dry and light, and can now be obtained in this country; light, sound Bordeaux and Rhine wines are suitable to some cases, but to a comparatively small number, so far as the writer has observed. Cider is also suitable for some patients. The most injurious are the beers, porters, either very sweet or brut champagnes, port, burgundy, and madeira.

With regard to exercise, it must be regulated according to the condition of the individual. Sedentary habits should be discarded, and if the patient's muscular force is good he should be urged to engage in the quieter out-door sports, and to remain out doors as many hours as possible daily. Golf is an ideal sport for such patients.

If the patient can do so in a warm, dry climate, one of the best ways to secure plenty of out-door air for him during the warm season is to have him go into camp, sleeping in a tent, preferably in the pine woods and at a moderate altitude. Riding on horseback for vigorous patients often keeps the enemy under control during the whole of their lifetime. The function of the skin should be carefully attended to by regular bathing and friction. For weak persons massage, alcohol and water sponge-baths, and for strong and plethoric ones occasional Turkish baths, are beneficial.

In cases of phosphaturia and oxaluria it is still more important to have the patients in a high, dry climate, and that they should have plenty of out-door life. Cold bathing is, so far as the writer has observed, injurious for these cases, but skin-frictions and alcohol sponge-baths are very beneficial. The anemia so frequently associated with these two conditions should be energetically combated by iron and a nutritious and varied diet. Nervous symptoms are, as has been noted, ordinary accompaniments of oxaluria, and care, worry, and all depressing influences should be, as far as possible, removed from the patient. Tonics are an important part of the preventive treatment of both oxaluria and phosphaturia. The amorphous sediment seen in the urines of phosphaturic patients can almost always be kept in solution by the administration of dilute phosphoric acid, which is best given in 15-minim doses in plain soda-water thrice daily with meals; the bladder irritability due to its presence will be relieved as a consequence, and sometimes there will be no return of the sediment after the drug has been suspended; but more often the benefit is temporary and the phosphatic deposit reappears when the drug is omitted: its value, therefore, is to avert the immediate threatening of stone-formation when the sediment is excessive.

Sir Henry Thompson does not commend a milk diet in cases of uric-acid diathesis. The writer's experience does not accord with this view. In his practice one of the most efficient methods of combating the uric-acid tendency and averting the immediate danger of stone-formation has been the long-continued use of milk diet, especially when combined with Vals water.

The tendency to constipation which milk diet causes with most patients must be guarded against by giving laxatives. Milk should not be taken cold, should be sipped and not swallowed quickly in large quantity; each glass should be diluted one-fourth with Vals water. Two or three quarts of milk are to be taken daily. Broiled fish and dry toast and some sort of light unsweetened biscuits may be added to the milk diet. Milk diet, while nourishing the patient thoroughly, does not supply muscular strength; consequently as much exercise cannot be taken as with a mixed diet, but the patient can be kept out doors quietly, at any rate. The diuretic property of milk is decided, and its effect in lessening bladder irritability is marked. Its use should not be continued uninterruptedly for more than six weeks at any one time.

A diuretic which the writer has found of great value, and has never seen mentioned for this purpose, is the drink made from cocoa-shells—the husk of the cocoa bean which is discarded in the process of preparing it for the finer drinking chocolate and cocoas. The shells when boiled for five minutes should then be strained off or they become bitter; milk and sugar added to this make a very pleasant drink.

In addition to the general measures referred to above, the bladder should be treated locally if there is cystitis or prostatic hypertrophy of such character as to call for the regular use of the catheter. The bladder-washes which in the author's experience are the most beneficial in cases of cystitis are very hot solutions of 4 per cent. boracic acid and of potassium permanganate 1 part to 3000 of water.

Of drugs, a few are decidedly useful: boracic acid and sandalwood oil are excellent when cystitis is present, the former especially freeing the urine of pus and mucus and preventing its decomposition in the bladder. Benzoate of soda frequently allays bladder irritability and increases the quantity of urine. Spirits of turpentine, recommended by Ralph of Oxford, the author has found to be of value in assisting the passage of renal calculus and of uric-acid sand from the kidney.

Solvent Treatment.—Efforts to dissolve stone have been made since time immemorial. In recent years the work of Roberts claims attention. His experiments deal with the solvent power of alkaline carbonates upon uric acid, and rendering the urine alkaline by their administration by mouth, with a view to producing the same effect in the body. He showed outside the body that carbonate of potash in the strength of forty grains to the pint exercised a more powerful solvent action than any other strength of the salt. Next he showed that the ingestion of about forty grains of acetate of potash every three hours rendered the urine as alkaline as an equivalent quantity of the carbonate given in a solution of the strength of fifty grains to the pint. Upon placing uric-acid calculi in urine thus rendered alkaline he found that they dissolve at the rate of about twelve grains in twenty-four hours unless the urine became ammoniacal; if it did, the calculi became encrusted with a layer of mixed phosphates which prevented future solvent action. Roberts's experiments failed to reach the desired goal—viz. the practical means of dissolving stone in the human body, nor has any one as yet demonstrated its feasibility.

Among the later drugs introduced as uric-acid solvents is piperazine, which seems to have more value than most of them. In the writer's experience its action has been very uncertain, sometimes having no effect, at others being followed by the rapid disappearance of uric-acid crystals from the urine in cases in which they had been present constantly for long periods, and by marked alleviation of many of the symptoms which are associated with the uric-acid diathesis. The dose is ordinarily five grains given thrice daily in water; this may be doubled with benefit, but it should be increased cautiously, for unpleasant symptoms occasionally appear, such as dizziness and prostration.

The lithia salts in some cases seem to exercise a solvent action upon uric-acid crystals in the urine, and are better borne by the stomach than the potash preparations, but by none of these means has stone been successfully dissolved in the bladder, nor have the attempts to accomplish this end by direct action of electricity or chemical agents given better results.

Operative Treatment.—*Historical Sketch.—Lithotomy; Lithotrity.*—References to the cutting operations for stone are found amongst the earlier writings of India. At the time of Hippocrates there was a class of men who operated solely for stone, and this custom has persisted until recent times, the art being handed down from father to son in many instances. Celsus mentions a certain Ammonius who, being unable to remove a stone from the bladder by the cutting operation, crushed it by means of a peculiar instrument. Paulus of Ægina also describes cutting operations. The Arabian and the Latin authors of the Middle Ages speak of the methods of Paulus and warn against their dangers.

Until the seventeenth century the methods of Paulus, Celsus, and Guidonioni were in vogue. In the operation of Celsus a scalpel alone was used. The operator introduced the index and middle fingers into the rectum and grasped the stone with them, and brought it forward against the perineum. A crescentic cut was then made across the perineum between the scrotum and the anus, with the convexity upward and terminating above the tuberosity of the ischium on either side. The soft parts were then divided and the bladder opened by a cut in the line of the original one; the stone was then expressed by the fingers in the rectum; this method was called "cutting on the gripe."

In 1543, Marianus Sanctus de Barletta described another method, since known as Mariani's method: this operation was characterized by the use for the first time of a conductor or guide upon which the cut into the bladder was made. The instrument was passed into the bladder through the urethra and held by an assistant, as is done to-day in performing lateral lithotomy: the cut was diagonal and a little longer than the width of the thumb-nail, and in a direction similar to that now used in the median operation. After dividing the skin the point of the knife was plunged through the soft parts directly down to the conductor. The urethra, and not the bladder, was opened upon it; another instrument resembling a catheter was next introduced through the wound, beside the conductor, into the bladder and the urine withdrawn. This instrument was then taken out, and in its place was passed another consisting of two solid rods called "ductores," and the conductor removed. A dilating instrument was then introduced between the rods, and the wound and the neck of the bladder were dilated; finally, the stone was removed with a pair of forceps between the "ductores." The operation of Marianus was a median one.

The operations of Celsus and of Marianus were called respectively the "apparatus minor" and the "apparatus major." The latter was practised by Pierre Franco, who is also credited with being the originator of the suprapubic operation, which he performed in 1560 on a child in order to extract a stone of the size of a hen's egg which he had failed to remove through the perineal cut. The patient recovered, but Franco did not urge the operation, and it was lost sight of for a long time; its subsequent reappearance and establishment will be considered under a separate heading, and we will now continue the consideration of the perineal methods.

The perineal methods were practised by priests and laymen as late as the earlier part of this century. The Franciscan monk Frère Jacques (Jacques Beaulieu) is said to have done several thousand perineal operations for stone. Rau, who was a barber, was also a successful operator.

The English surgeon Cheselden was the first to place the lateral perineal operation on a scientific anatomical basis, and the results of his operations were so good that it became popular throughout France, Germany, and England. Cheselden's incision divided the prostate's left lobe entirely.

Le Cat modified Cheselden's incision by limiting it to a partial division of the prostate only, and he entered the bladder by a blunt dissector after having cut through the outer tissues.

Hawkins introduced the cutting gorget at the end of the last century.

With slight modifications modern lateral lithotomy is the same as the operation of Cheselden. That surgeon at the end of his career (about 1732) had performed 213 lateral lithotomies with a mortality of 5 per cent.: this favorable result was no doubt due in part to the fact that a large number of his patients were children, 105 of them being under ten years of age.

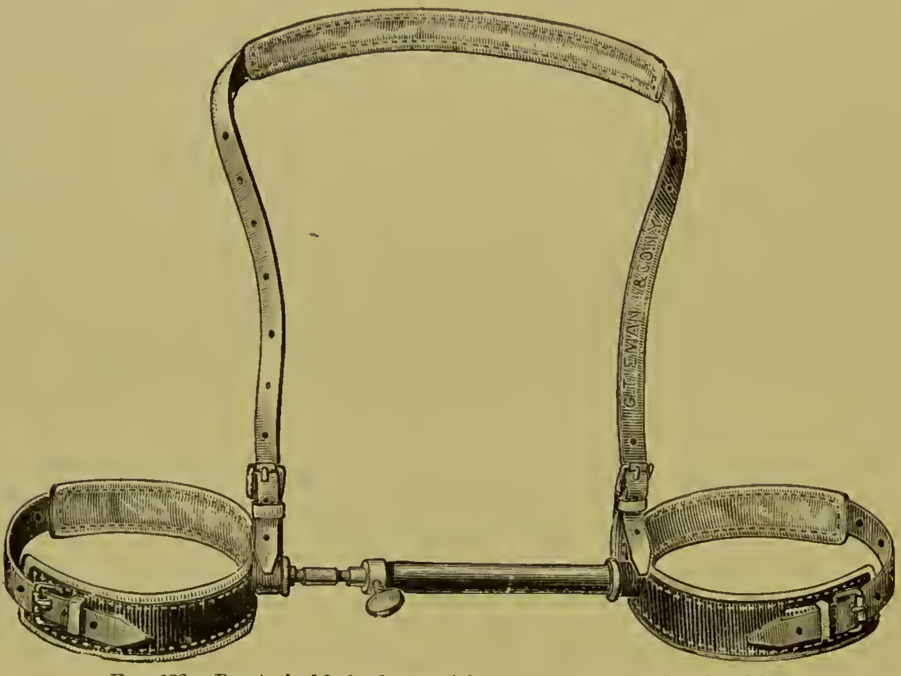
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FIG. 133.—Bar to hold the legs, with strap to go over the shoulders.

The modern operation of lateral lithotomy is performed as follows: A full-sized staff having a groove on one side is passed into the bladder, the patient lying on his back. Some operators prefer a staff with a groove in the middle, in which case the assistant who holds the staff should turn the shaft of the instrument so as to bring the groove to the patient's left side. The cut should never be made until the stone at the time of the operation has been felt by the operator, since instances have occurred through lack of this precaution of the bladder having been opened in which there was no stone. The legs are now flexed to about a right angle with the table and each supported under the knee by an assistant; this is a better position than that of sharply flexing the legs on the abdomen, which is the one more usually practised, and which is generally accomplished by means of a mechanical contrivance having the form of a yoke, of which there are several varieties; that devised by Clover (Fig. 133) is the form usually employed. Fig. 134 illustrates another improved form of this appliance; it is the invention of Dr. F. Tilden Brown of New York, and of which he speaks as follows:

"The main faults in the Clover crutch are the straight bar and the neck-strap. The former seriously invades the operative territory. In urethrotomy it is near enough to the penis to encroach upon some part of the arc which the handle of a sound or grooved staff must traverse to enter or leave the urethra. It invariably causes the operator to use undue force and a false lateral position to crowd the handle of the instrument under the bar.

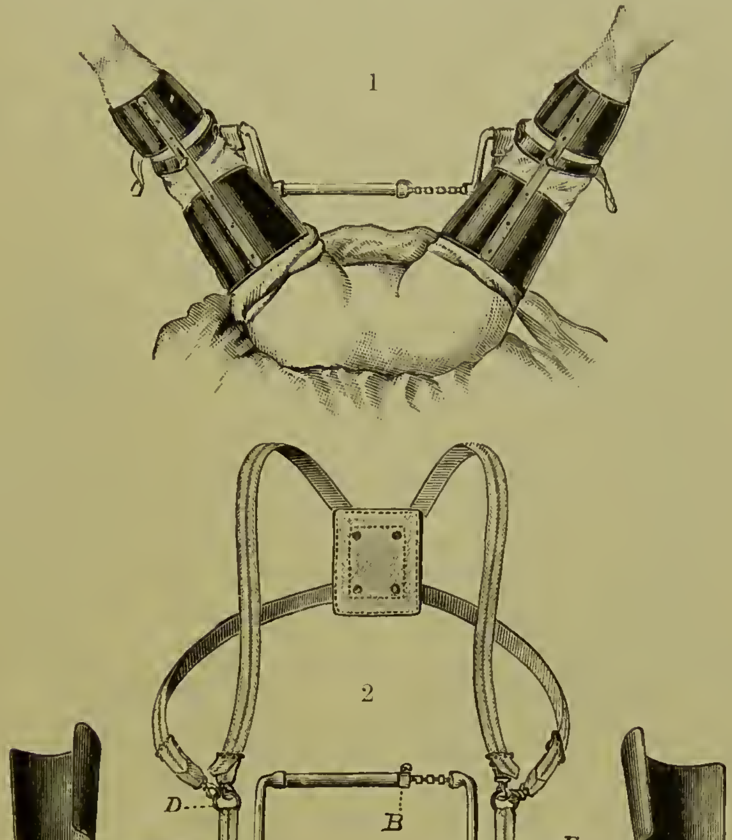

Fig. 134.—1, showing exposure of the perineum and position of the legs with the Brown surgical crutch applied; 2, component parts of the Brown crutch: *A*, point at which the arms of the extension bar swivel in the leg-crutch; *B*, spring pressed upon to close the extension bar; *C*, key on the leg-crutch which engages in the slot *C′* in the leg-rests and locks them together; *D*, the point where the two parts of the apparatus are joined by ring- and snap-catches when the crutch is on and the thighs are flexed; *E*, canvas strap which buttons over when the leg lies in the crutch. Dotted outlines show the position of the extension-bar if turned downward. As only canvas straps and nickeled metal enter into the make-up of the apparatus, it can be washed and sterilized.

"In operations upon the rectum, perineum, or vagina this straight bar, hung with sterilized cloths, shuts off light from the field of operation and fills the space convenient for instruments.

"The single neck-strap is faulty in that it exerts a considerable pressure upon the vessels and nerves of the neck, the deleterious effects of which are clearly marked in the congested state of the head and the unsatisfactory respiration during anesthesia. These phenomena are particularly noticeable when the patient is flabby, plethoric, or alcoholic—that is, it intensifies the dangers incidental to the anesthetic state commonly noticed in just such cases."

The proper position having been secured by these or some similar device, the staff is now made prominent in the perineum, and held steadily in the middle line by an assistant, who also holds the penis and scrotum up on the staff, lifting them up as high as possible so as to stretch the urethra and to pull its bulbous portion upward above the line of the incision, thus avoiding cutting the artery of the bulb. The staff must be kept in one position, and its curve should be hooked up against the under side of the pubic arch. The bladder may be filled with six or eight ounces of water or be left empty, according to the preference of the operator."

The incision recommended by Sir Henry Thompson is described by him thus: "It begins about an inch and a half in front of the anus and a third of an inch to the (patient's) left of the raphé; from this point it is carried obliquely across the perineum to terminate near the tuberosity of the ischium. The first part of the cut is to be made deeper than the last part of it. The staff is approached in this first incision, but not exposed; the left index finger is then introduced into the wound, the cellular tissue separated by it, and the staff felt for. A touch or two of the knife will now open a way close down to the staff; the finger-nail is now inserted firmly into its groove on its inner side and well back, so as to avoid the bulb, and at the same time to guard the rectum with the body of the finger; the point of the knife is then pushed into the groove of the staff, the blade being held horizontally by the side of the finger-nail, care being taken that the point actually reaches the bottom of the groove and that it has penetrated all the tissues. The point of the knife is then run steadily on, horizontally, along the groove, always keeping the point of the blade firmly pressed against it, through a portion of the prostate and into the bladder. If there is a large stone present, the cut should be enlarged, more or less as may be needed, by turning the blade a little to one side and cutting lightly as the knife is withdrawn in that direction. The gush of urine attests the entrance of the knife into the bladder. The finger is now passed along the staff and into the bladder; the staff is then withdrawn by the assistant; next the forceps are slid along the finger into the bladder. The blades are then opened widely, one being held firmly down on the bottom of the bladder, and the other reaching to its top; on closing them the stone will usually be found between them. The fore finger, which has been retained in the bladder, adjusts the stone in the blades in such a way as to make its extraction easy. The wound has been dilated by the finger and the forceps, and the stone, firmly held in the blades, is now drawn out through the wound, traction being made in a downward direction and the handles of the forceps being occasionally moved from side to side. If the patient has a very narrow and deep perineum, a gorget with a thin but not a cutting edge may be introduced into the wound, instead of the finger, to facilitate the passage of the forceps and the extraction of the stone. The gorget with a cutting edge has been discarded for the most part. The object of the instrument is to dilate the wound in the bladder by cutting if it has a sharp edge, or by simple pressure if a dull one; the finger and the lithotomy forceps are, however, better means of accomplishing this result."

Other instruments have been contrived at different times for enlarging the bladder-wound, and even for doing the whole operation, cutting, extracting, and all, mechanically, but they have never found favor, and are not used.

A very serviceable maneuver when opening the urethra on the groove of the staff, and when prolonging the incision to the bladder, is that of drawing the penis well forward on the shaft of the staff, at the same time raising the staff itself against the pubic arch; this carries the bulb up out of reach of the knife, and it will rarely be wounded if this precaution is observed. Hemorrhage, which may be severe, arises ordinarily from the artery of the bulb or the anterior portion of the venous plexus around the prostate, or in the form of a general oozing from the cut surfaces of the gland; the latter is usually unimportant. The source of the bleeding should be carefully sought, and all arterial branches should be tied; the venous bleeding and the oozing are best stopped by tamponing the wound: for this purpose the most convenient instrument is the "cannula à chemise" (Fig. 135). It is a metal tube with a round end, and one or more holes on its sides near this end to allow the exit of the urine through it from the bladder; just below these holes is a ridge which allows a layer of sterilized gauze in the form of a petticoat to be firmly tied to the tube, over the rest of which it falls. The tube with its petticoat attached is passed into the bladder through the wound, and pieces of gauze are then packed up under the petticoat until sufficient pressure has been made to arrest the bleeding.

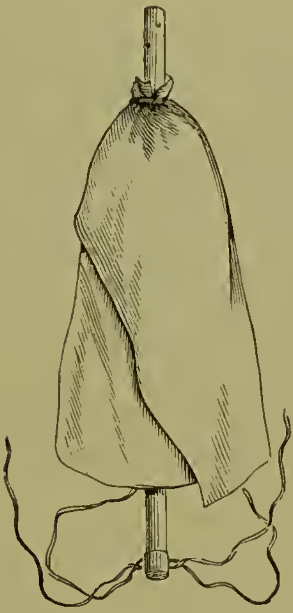
FIG. 135.—Cannula à chemise.

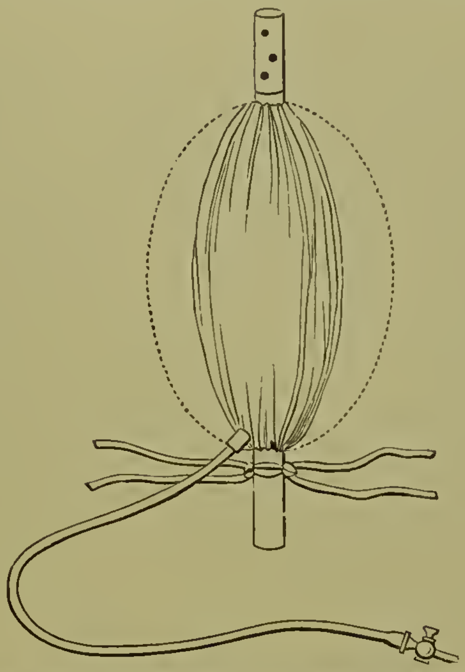
FIG. 136.—Buckston Browne's air-cannula à chemise to control hemorrhage after lithotomy.

The best contrivance is that of Buckston Browne (Fig. 136). The advantage of the air-tampon is that the pressure can be gradually lessened, and the instrument withdrawn with much less trouble to both surgeon and patient; it is also more rapidly and readily applied. Ordinarily there is but little hemorrhage; there is, then, no necessity for a drainage-tube, in the bladder at any rate; the outer part of the wound may be packed lightly and a drainage-tube carried through the middle of this dressing to facilitate the passage of the urine for a day or two, after which a simple gauze dressing laid upon the wound and changed as often as it becomes soaked is all that is required.

The bladder-wound in children often heals over in a very short time, sometimes in forty-eight hours; with adults it is frequently prolonged for a considerable time; urinary fistula, however, rarely results.

The seminal duct is liable to be severed in the operation, especially in children, in whom the prostate is not developed, and in whom in consequence all the adjacent parts are closer to the line of incision. This accident may be avoided by making the bladder and prostatic incision more horizontal than the outer cut is. When the injury does occur, sterility and impotence may result; the latter is rare, and the former is probably due to loss of ejaculatory power from injury to the perineal structures and prostate, and not to the inability of the transmission of semen through the seminal ducts or from the opposite testis, although a closure of the former, through their being involved in the cicatrization of the wound and their consequent occlusion, may occur.

Occasionally also incontinence of urine may result from the complete division of both sphincters of the bladder by the lateral perineal incision. Injury to the rectum should not, but now and then does, occur in making the lateral cut. It is doubtful if stricture results from it, though Cabot[1] mentions a case in which he observed such a result, the membranous urethra being narrowed to 25 French, while the rest of the urethra had a caliber of 31.

Some surgeons have attempted to secure union by first intention of the wound after the lateral perineal cut—notably Crichton, who claimed to have succeeded frequently in so doing. Nevertheless, this practice has not found favor, chiefly owing to the danger of urinary infiltration.

Various modifications of the perineal incision have arisen from time to time: these are the bilateral of Dupuytren, modified by Vidal de Cassis into the so-called quadrilateral cut; the medio-bilateral cut of Civiale; Nélaton's and Reliquet's pre-rectal operation; Allarton's median cut; Dolbeau's operation; Buchanan's; Sanson's recto-vesical incision for large stones, etc. Of these, Dupuytren's, Dolbeau's, and Civiale's only will be referred to.

Dupuytren sought to avoid the hemorrhage that is incurred in the lateral operation: this he accomplished by making a crescentic cut across the perineum between the anus and the scrotum, with its convexity upward, and continued through the tissues between the bulb and the rectum until the guide is clearly felt. The membranous urethra is then opened just enough to admit the tip of the two-bladed lithotome, which is then pushed along the groove of the guide into the bladder. As soon as the stone is felt the blades of the lithotome are sprung and the instrument withdrawn, making as it passes outward an oblique incision through each lobe of the prostate. This gives a good-sized space through which to extract the stone.

Civiale's differs from Dupuytren's operation in exchanging the crescentic outer cut for a median one through the raphé: Civiale used a straight, instead of a curved, two-bladed lithotome.

Dolbeau's method consisted in dilating the deep urethra with a special instrument, after opening it in its membranous portion by a median incision on a grooved staff; through this route small stones could be readily extracted, while he crushed the larger ones before extracting them, thus combining lithotrity and lithotomy. In 1888, Reginald Harrison urged the more frequent practice of this operation, especially in cases of old men with enlarged prostates, modifying it in certain respects. Harrison devised a special form of powerful forceps for crushing the stone previous to extraction. He accomplishes the dilatation of the deep urethra by passing through it first the little and then the index finger, after laying open the membranous urethra in the usual way. The blades of these forceps look large, but they will pass without injury into the bladder through a urethra that can be dilated enough to admit the index finger. This method has much to recommend it: it secures the rapid fragmentation of the stone, the pieces of which can be quickly removed with an evacuator of a very large caliber; it avoids the danger of wounding a prominent enlargement of the third lobe of the prostate, which may happen with the lithotrite, when used through the whole urethra, even in skilled hands, which is the most dangerous accident at all likely to occur in the course of lithotrity; it avoids hemorrhage and injury to the seminal ducts, liable to occur in the course of lateral lithotomy; and finally, except in cases in which the prostatic urethra is much elongated, it permits digital exploration of the bladder and the consequent assurance of the removal of the last fragment of stone.

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[1] Morrow's *System of Genito-urinary Diseases.*

Of all the perineal operations, this one of Harrison and the lateral cut are the best, and, of the two, the former is in the writer's opinion preferable in the class of cases for which it was designed, while for children the latter should be preferred, because the small size of the urethra does not allow the passage of the large, powerful forceps, and because of the uniformly good results attending the lateral operation in children. J. Forbes Keith of Delhi, India, is a strong advocate of the median perineal method, and has further modified it. His plan will be referred to later.

The Suprapubic Operation.—This method originated, as has already been mentioned, with Pierre Franco about 1550 when operating for stone upon a child, and, being unable to extract it through the perineal route, he cut down upon the bladder above the symphysis and succeeded in removing it. The stone was the size of a hen's egg. The patient recovered. Franco repeated the operation several times subsequently, but did not recommend it for ordinary cases. He recognized at once the value of raising the bladder above the symphysis, and partially accomplished it by pushing it upward with two fingers in the rectum. Somewhat later Rousset of Montpellier sought to effect this maneuver by distending the bladder with water.

The operation was not much practised until it was revived by Douglas and Cheselden in England in 1723; between 1758 and 1778 its practice was continued by Frère Côme, who introduced the instrument known as the *sonde à dard:* this was a cannula having the curve of steel sounds such as we use now; a sharp-pointed stylet lay within the cannula, and could be projected beyond its end after it had been passed into the bladder. The anterior wall of the bladder was transfixed by the point of the stylet, and the organ lifted upward and forward against the abdominal wall by it.

Up to 1830 the operation was in vogue, and frequently practised by various surgeons—Dupuytren, Amussat, Souberbielle, etc. Souberbielle performed it 50 times, with a mortality of 22 per cent. In Germany it was generally reserved for cases of very large stones, such as could not be removed through the perineal route. Between 1840 and 1880 the operation steadily declined in popularity, being more dangerous than the perineal ones, and because of the introduction of lithotrity and its steadily increasing success; but in 1880 it was again revived by the introduction by Petersen of certain modifications and the anatomical demonstrations of Garson of Glasgow. The proposal of Petersen was to raise the bladder out of the pelvis by means of inflating with water a bag previously placed in the rectum, the bladder being also filled with fluid. By this elevation of the bladder the peritoneal reflection on its anterior surface is raised to from two to four or even more fingerbreadths above the symphysis, and so escapes being wounded. To this procedure and to the application of aseptic methods the suprapubic operation primarily owes its present popularity.

The technique of the operation by Petersen's method is as follows: The pubic region is shaved and aseptically prepared; a metal catheter is introduced into the bladder and the organ cleansed with boracic-acid irrigation; a rubber bag capable of holding twelve ounces of water is greased, folded upon itself longitudinally, and introduced into the rectum, so that its lower end lies above the internal sphincter, the rubber tube through which it is filled extends externally about five inches. In the adult ten ounces of water, and in children five, are injected into the bladder. A piece of tape is tied around the penis so as to prevent the outflow of water from the bladder. Eight or ten ounces of water are now injected into the bag. Unless the bladder is confined to the symphysis by adhesions or is thick-walled and of small capacity, it will rise under this double injection prominently in the lower part of the abdomen, lifting the peritoneal fold from two to four finger-breadths above the bone (Figs. 137, 138). The bladder may be exposed by either the usual vertical incision between the recti muscles or by a crescentic cut having the center of its convexity a little above the middle of the symphysis, the prevesical space being laid open by deeper incisions through the muscles on the same line, or by a compromise, which the writer prefers, by employing the crescentic cut for the skin and then exposing the prevesical space by the vertical incision, the advantage being that it is very easy to see the line of division between the recti as soon as the skin-flap has been turned up. There is little to recommend the transverse cut into the bladder proposed by Von Antal and referred to above. The prevesical space is recognized at once by its fat-contents; within this lies the peritoneal reflection on the anterior surface of the bladder. At this point there are two ways of proceeding: the fat-layer can either be divided with blunt-pointed scissors, or it can be lifted up from behind the symphysis by the finger. The writer prefers the former, for the reason that

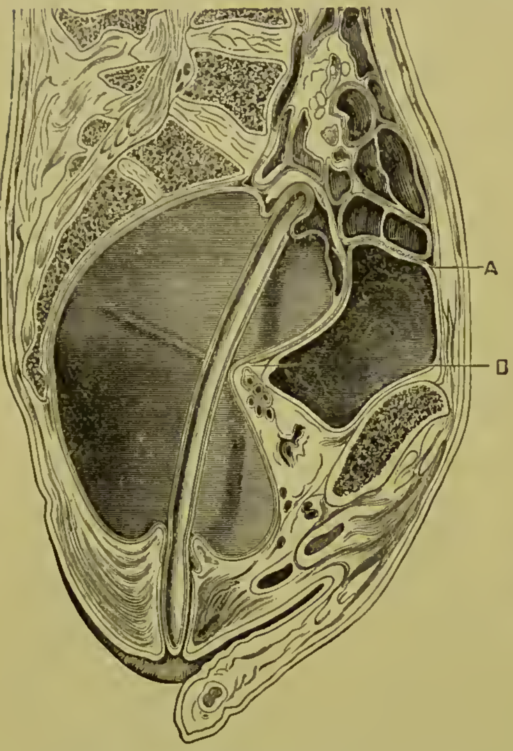

FIG. 137.—Bladder containing six and a half fluidounces; rectum distended with fifteen fluidounces; *A* and *B* mark the peritoneal folds.

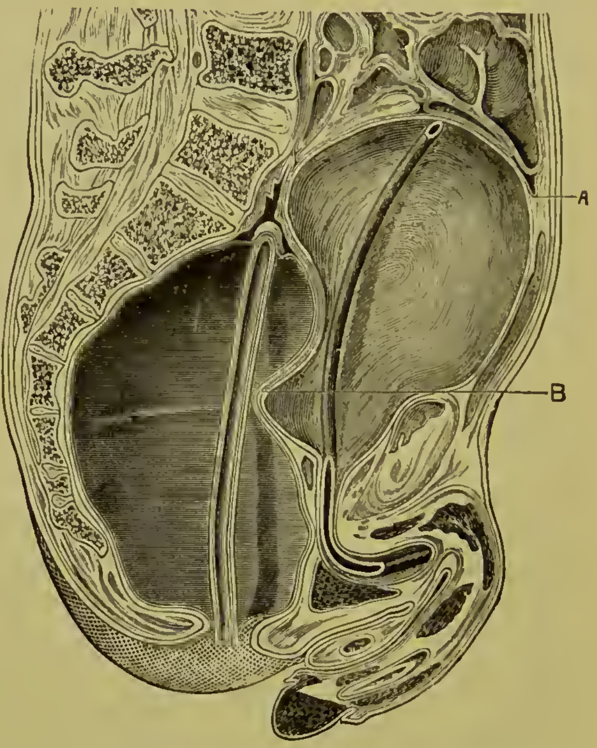

FIG. 138.—Bladder containing fourteen fluidounces: rectum distended with sixteen fluidounces; *A* and *B*, folds of peritoneum.

it disturbs the anatomical relations of the prevesical space much less than the latter, especially if the subject be a fat one, for in that case there is always a large quantity of fat the removal of which from its normal position leaves a cavity behind the symphysis in which the urine collects and may subsequently give rise to septic phlegmon.

The only objection to dividing the fat is the danger of wounding the peritoneal fold, but with ordinary care this need never be done. It is readily distinguished by its smooth, glistening surface. Should it be wounded, the opening should be promptly sutured, and no harm need be feared. Beneath the fat-layer lies the bladder. It is recognized by its dull bluish color and by the large veins ramifying over its surface. A tenaculum is now hooked through the bladder-wall as high up on its anterior surface as the peritoneal insertion will permit without injuring it; it must not be passed through the latter. Two stout sutures are next passed through the bladder-wall, one on either side, and held by an assistant, or, better, attached to the edges of the abdominal wound at once or as soon as the bladder is opened. The bladder is then opened vertically by one bold incision in the median line, the cut being longer or shorter according to the size of the stone to be extracted. If the peritoneal fold is inserted too low to allow of a long incision, and yet a large wound is required, the additional space can be gained by incising slightly the edges of the bladder-wound on either side. The contents of the organ flow out at once as soon as the cut is made; the rectal bag may now be emptied and removed. Hemorrhage from the veins on the surface of the bladder is ordinarily unimportant, and generally subsides spontaneously on the removal of the rectal bag.

Some surgeons prefer to elevate the bladder by filling it with air rather than with water (Bristow, etc.), asserting that a better lifting above the symphysis is thus accomplished.

There are certain accidents possible in the performance of the suprapubic operation by the method of Petersen: these are—laceration of the rectum and rupture of the bladder. Soon after its introduction such cases were reported from various sources (Guyon, Dittel, Weinlechner, and others), and in one or two instances these accidents happened when not more than five ounces had been placed in the bladder and in the rectal bag respectively. This is most likely to happen with bladders having thin-walled diverticula and thick, non-distensible coats. The laceration of the rectum is best avoided by using a sausage-shaped bag instead of the more rounded or oval forms. The possibility of rupture of the bladder should always be borne in mind, and guarded against by observing the condition of the bladder in each individual case, and regulating the amount of injection accordingly. The injection should be stopped whenever any undue resistance is felt. This accident will be of rare occurrence if not more than eight or ten ounces are used in the bladder and the rectal bag respectively. Many operators have abandoned Petersen's method, and either cut down on the empty bladder, as was formerly done, or employ the postural method of Trendelenburg, by which the pelvis of the patient is raised and the shoulders are lowered: by this means the bladder is lifted out of the pelvis, following the abdominal viscera as they descend (in the inverted position of the body) toward the diaphragm.

After opening the bladder the removal of the stone is accomplished with forceps. If the stone is very large, it should be crushed, if possible, with suitable forceps and removed piecemeal; the wound of the bladder must be enlarged, and it may be necessary to carry the incision upward through the peritoneal investment; this procedure will be referred to later. The bladder-wound may be treated in one of two ways: it may be left open or sutured. The former is more frequently practised in France. When the open method is employed, two parallel drainage-tubes are inserted into the bladder, and the bladder-wound is sutured around them; the tubes are led out through an aseptic dressing which covers the wound, and carried to a receptacle in or beneath the bed. If the tubes are properly placed, they siphon out the contents of the bladder and the patient is kept perfectly dry. One tube may be removed about the third day, and the second usually about the tenth to the fourteenth. If there is cystitis, the drainage may often be prolonged with advantage. If the drainage has not been prolonged, the wounds ordinarily heal without difficulty in from sixteen to twenty-five days, and it is rare to have a fistula persist.

The second method of treating the wounds, that of suture, dates back to Lotzbeek in 1838. He closed the bladder-wound wholly, leaving the sutures hanging out of the abdominal wound at its lower angle, and closing it except at this point. He had entire success in 3 cases.

Many varieties of suture have been devised and used for closing the bladder. The best form is that which will close the wound most securely, and is at the same time capable of being rapidly applied. The writer prefers the right-angle suture of Dr. H. W. Cushing of Boston, which he uses for intestinal wounds (Fig. 139).

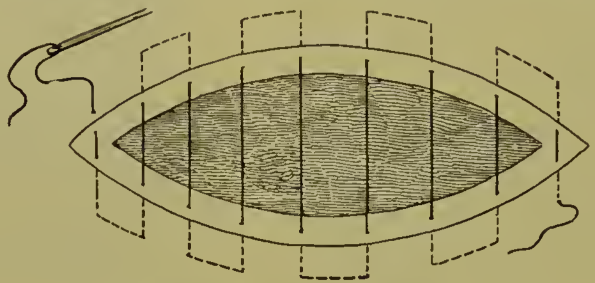

FIG. 139.—Cushing's suture.

The double purse-string form, introduced by Brenner, is also an excellent one (Fig. 140).

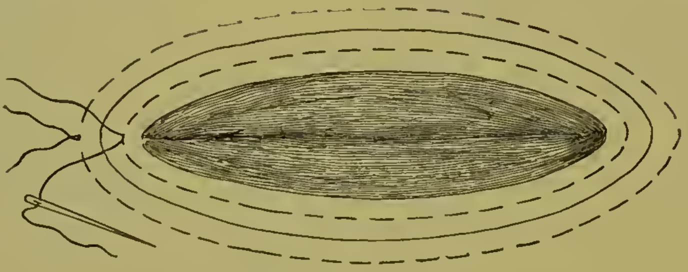

FIG. 140.—Brenner's suture.

Bouley's interrupted suture is a convenient form.

The especial form, however, is of less importance if the two chief desiderata already noted are secured. During the earlier history of bladder-suture, after 1882, it was customary to leave the greater part of the abdominal wound open to avoid the danger of urinary infiltration in case the suture did not hold perfectly, but recently it has been shown that a larger percentage of success follows the complete closure of both the bladder and abdominal wounds.

Dittel[1] in 1894 reported 32 epicystotomies for stone, with a mortality of

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[1] *Wiener klinische Wochenschrift*, Nos. 33 *et seq.*

15 per cent. In 16 of these he employed *total suture;* in 6 only was there a failure of primary union of the wound. He notes the fact that in 12 cases in which he used the *partial suture* only the time of convalescence was shorter than in the 16 others of total suture just referred to.

Zsemacki[1] makes the following recommendations with regard to bladder-suture: (1) The bladder-wound should be entirely closed by silk suture in all cases except in the presence of a foul cystitis and abscess of the prevesical space. (2) Tilling's interrupted two-étage suture, one involving the prevesical cellular tissue, is best. (3) The abdominal wound should be closed except at its lower angle, into which a drain or wick should be introduced reaching to the vesical suture. (4) A catheter *à demeure,* arranged so as to act like a siphon, should be left in for at least twelve days after operation in the adult, and for a somewhat shorter period in children. (5) If the bladder suture gives way or suppuration arises, the wound should be at once opened and drained. The following things should be strictly avoided: (1) The use of catgut for closing the vesical wound; (2) a single row of sutures, purse-strings, Ferrier's, or too numerous or too tight sutures; (3) leaving open the muscular wound of the abdominal wall; (4) the use of a catheter *à demeure* with a strongly curved end.

Nikolas V. Solonika in 1889 (at St. Petersburg) analyzed 491 cases of suprapubic cystotomy performed by Russian surgeons between 1823 and 1888. Of these, 486 were for vesical calculus, 62 of them being done in the pre-antiseptic period and 424 in the antiseptic period: the mortality of the former group was 30 per cent., of the latter 11 per cent. The ages of the patients are given in the following table:

Years.	Patients.	Died.
1 to 5	120	17
5 “ 10	117	10
10 “ 15	43	6
15 “ 20	23	3
20 “ 25	30	5
25 “ 30	18	1
30 “ 35	6	2
35 to 40	5	1
40 “ 45	4	3
45 “ 60	12	3
60 and upward	11	3
Not known	35	5
Total	424	59

In 69 cases the vesical wound was totally closed; in 48 only partially; in 6 the edges were stitched to the abdominal wound. The mortality in the cases of total closure was as low as 5.8 per cent., notwithstanding the fact that in 43 per cent. the urine was very considerably changed. In 34.8 per cent. of the cases the wound healed *per primam,* the after-course being either wholly apyretic or nearly so. In 67 of the 69 cases a catheter *à demeure* was employed. Solonika concludes that with but few exceptions the vesical wound should be totally sutured, the best method being the étage-suture of Tilling, and the best material chromicized catgut and a round needle. The abdominal wound should always be closed down to the site of the drainage.

Assenfeldt (Nijni-Novgorod, Russia) reports 102 cases of suprapubic cystotomy performed by himself since 1853: 98 of these patients recovered. The bladder was sutured in all cases in which the urine was normal. Out of 74 of the sutured cases, in which the post-operative course is noted, union by first intention occurred in 20. In 60 cases the patients were under ten years of age; 32 others were under twenty; the remaining 10 were between twenty and thirty. It will be noticed that the large majority of these patients are under twenty-five years of age. The favorable results of suture may be in some measure due to this fact.

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[1] St. Petersburg, 1889.

It is interesting to note that Page of Leeds, in a recent number of the *British Medical Journal*, reports 2 cases of suprapubic cystotomy in which union of the bladder-wound by first intention took place, although no sutures were applied and no attempt to secure the immediate closure of the wound was made, beyond omitting all drainage and packing of the wound.

Outside of these special computations, it may be said that surgical opinion to-day favors the use of total suture of both the bladder and abdominal wounds in those cases in which suture is applied at all. But it is divided as to whether the treatment by suture or the open method is the better. The latter should, as a rule, be preferred in cases of old men with prostatic enlargement, and the drainage should often be continued as the best means of treating the cystitis so frequently presented in those cases.

The duration of convalescence under the open method is not, as has been already suggested, much longer, in many instances, than it is by that of total suture, even when the latter is successful. The subject must, however, be still considered to be *sub judice*.

Of the cutting operations there remain to be mentioned the modification of the high incision proposed by Helferich, the subpubic operation of Langenbuch, the method of Neuber by successive operations, and the intraperitoneal method introduced by Rydygier. Of these the last only claims more than passing notice. Rydygier operated by this method in December, 1887, on a thirteen-year-old boy, and with success. In performing it the following steps are observed: The field of operation is made thoroughly aseptic, the bladder thoroughly cleansed, and a large catheter is inserted into it and retained. The bladder is exposed in the usual way. It is then drawn up and fixed to the abdominal wound in such a way that the peritoneal cavity is shut off and that no urine can enter it. The bladder is then opened and the stone removed. The temporary sutures are now removed and the bladder and abdominal wounds are tightly sutured. (It is understood, of course, that the bladder-wound has been made through its peritoneal investment.) This method has been used in several cases for various intravesical conditions. It has been urged by Dr. Frank Harrington of Boston in an interesting article in the *Annals of Surgery*, October, 1893; he reports a case in which he entered the bladder in this way with excellent result. The advantage of operating by this method is that it affords more room. The bladder can be drawn up toward the surface, and sometimes outside the abdominal walls, which permits more thorough and easier manipulations within the organ, and, finally, the chance of union of the wound by first intention, if it is sought, is much greater.

Langenbuch's operation consists in entering the bladder under the pubic arch, between it and the root of the penis. Its proposer thought thus to secure better drainage and a better chance of primary union. Neither claim has been substantiated, and the operation is open to serious objection on the grounds of liability to injury of the blood-vessels of the penis, the greater risk of sepsis, and of its failure to secure any advantage not offered by other methods.

Neuber's method has justly never found favor.

Helferich proposes to make a partial resection of the upper margin of the symphysis pubis in order to gain more room in cases of very large stones, and his method of securing this end might in some very rare conditions recommend itself, but the same object can be better accomplished by Rydygier's intraperitoneal incision just described.

Lithotrity.—*History.*—According to Ultzmann, this procedure is a very old one. He quotes Olympios of Athens as having shown that it had been done in the ninth century, and continues as follows: "At any rate, we find places in the biography of the Holy Theophanes which indicate that instruments for crushing stones in the bladder and removing them afterward were introduced through the natural urinary passages. Abulkasis describes instruments by means of which stones could be removed from the bladder and urethra. Benedetti and Sanctorius, in the sixteenth century, also described the crushing of stone in the bladder: the results of the various operations referred to during these periods were in no wise encouraging, and the establishment of lithotrity did not take place until the present century. The first impulse was given to it by a Bavarian surgeon in Salzburg, by the name of Gruithuisen, in 1813; he proposed, but did not execute on the living subject, the following method of crushing stone in the bladder: A hollow, straight metal tube was to be passed into the bladder through the urethra, carrying within it a loop of wire by which the stone was to be caught up and drawn firmly against the end of the tube, and then split by means of a sharp-pointed stylet pushed in through the tube. In 1817, Fournier of Paris made stone-crushing experiments upon the dead body with instruments of his own construction. In 1818 young Civiale published his work upon lithotrity, and gave in it his idea of the instruments by which it should be accomplished. In 1819, Elderton, a Scotch surgeon, published a description of a method for crushing stone with a new instrument. In 1822, Amussat attempted to crush a stone in the dead subject by means of forceps of his own construction before a commission of the Academy; he broke the instrument instead. Simultaneously, Leroy d'Etiolles described a new instrument. Thus far, however, there had been only propositions, and on the 13th of January, 1824, for the first time, Civiale actually crushed a stone in the living subject by means of his improved instrument, which was a three-bladed forceps lying within a straight, hollow metal tube, from which the blades could be projected and spread after passing the tube into the bladder. The stone was grasped by these arms, and when firmly caught was perforated by a sharp stylet passed through the tube and between the branches of the forceps: as soon as it was broken the blades of the forceps were loosened and the stone allowed to drop out of them; the pieces were then grasped again and similarly broken. By this exceedingly clumsy mechanism Civiale operated upon 12 cases, being successful in 11 of them. In 1827, Eisenstein, who had studied in France, performed his first lithotrity in Austria. In 1831, Pirogoff introduced the operation into Russia. Heurteloup first performed it in England at Westminster Hospital, July, 1829. In America the first lithotrity was done in New York by Dupeyre in 1831, and came rapidly into favor there. It is of interest to know that Sir Henry Thompson possesses the instrument with which Civiale performed his first lithotrity.

Civiale left the fragments to be passed by the natural expulsion of the bladder. The first improvement of importance in the crushing instrument was devised by Weiss of London very soon after Civiale's first operation, and consisted in a two-bladed instrument made on a plan similar to that of the modern lithotrites. Heurteloup effected the breaking of the stone after it had been caught in the blades of the lithotrite by striking the end of the inner blade with a hammer. The method of breaking with the hammer was soon superseded by that of applying the crushing force by means of a screw, which originated, according to Sir Henry Thompson, with Mr. Hodgson of Birmingham: this was again modified by substituting a rack and pinion, introduced by Sir William Ferguson. The next mechanical advance was made by Civiale again and Charrière, and was the substitution of a wheel-handle at the instrument attached to a mechanism in the upper part of the shaft, by which the screw power could be changed for a sliding of the blades. Thompson devised the cylindrical handle, and modified the adjustment that governs the change from screw to a sliding motion of the blades, and also employed a fenestrated blade to clear the jaws of the débris, so that the withdrawal of the instrument was obviated (Fig. 141). The jaw of the male blade was variously modified by roughening it, furnishing it with teeth, projections, etc., all designed to improve the grasping power on the stone.

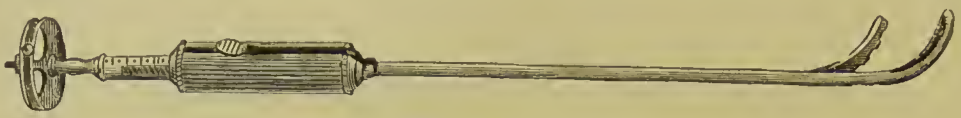
Fig. 141.—Thompson's lithotrite.

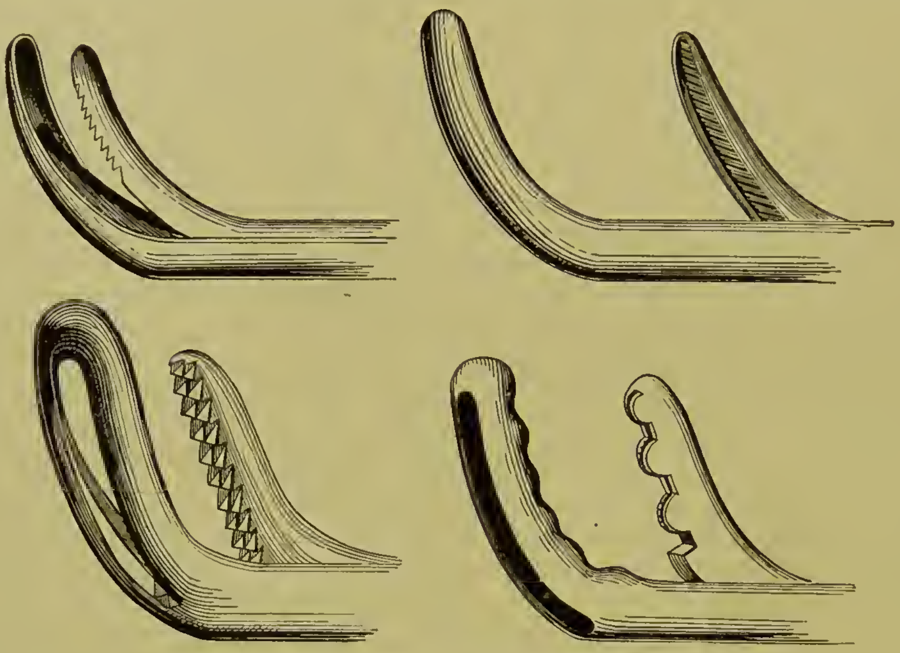
Fig. 142.—Some modifications of the lithotrite blades.

In 1878 there came another important change in the lithotrite, by which the desiderata were embodied in a new form of instrument by Prof. H. J. Bigelow of Boston, which will be described with the account of his operation under a separate heading. With this exception the accompanying figures

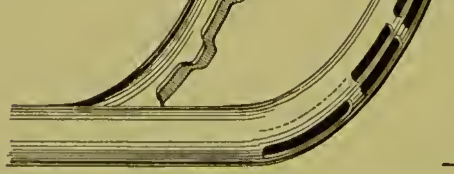
Fig. 143.—Fenestrated blades of Robert and Collin.

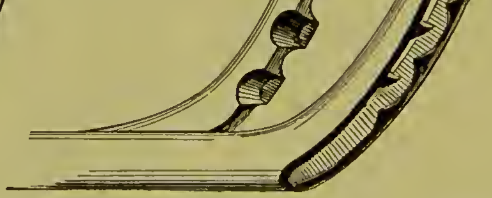
Fig. 144.—Fenestrated blades of Roliquet.

represent the more important steps in the subsequent development of the lithotrite.

During the earlier period of lithotrity there was no attempt to withdraw the crushed fragments from the bladder; they were left to be passed by the natural efforts of expulsion. The amount of crushing and the time occupied in each sitting varied with different surgeons; but there was no attempt on the part of any of them to complete the crushing and to remove the entire débris at one time, until Bigelow promulgated this principle in 1878 under the name of litholapaxy. Previous to this time lithotrity by frequent short sittings, by which was meant crushing of a small portion of the stone only, and leaving the fragments to be passed naturally or withdrawing them by means of the imperfect evacuators in use up to that time, was taught by Civiale and Nélaton in France, Thompson in England, Dumreicher and Dittel in Austria, and was the generally accepted rule.

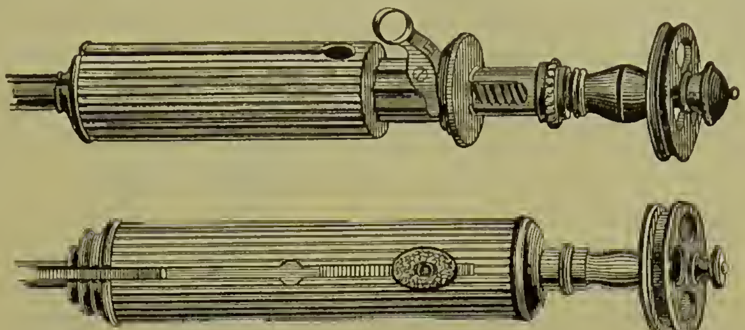
FIG. 145.—Thompson's modifications of the lithotrite handle.

The importance of removing the fragments, as far as possible, immediately after the crushing was recognized, however, early in the history of the operation, and was attempted by means of scoop-catheters, etc. The first apparatus for doing this by suction was invented by Sir Philip Crampton of Dublin in 1846; it had the form of a soda-water bottle with a catheter and stop-cock attachment; suction to withdraw the débris was accomplished by exhausting the air from the glass receiver beforehand. Cornay produced suction by means of an exhaust syringe attached to a wash-bottle. In 1865, Clover introduced an evacuator, which was a decided improvement over those that had gone before. Instead of the wash-bottle made of glass, it had a rubber bag attached to its farther end by which the fragments were sucked through the catheter, and a trap to catch them and prevent their return to the bladder with the ingoing stream. Thompson modified this instrument, and up to 1878 he had used the Clover instrument several hundred times. The various modern evacuators are figured later.

Litholapaxy.—In 1878, Bigelow, as has been said, introduced a new method of operating which he termed litholapaxy (*lithos*, stone, and *lapaxis*, evacuation), which revolutionized the operation of lithotrity, rapidly established itself, and has, up to the present, remained the universally accepted operation. Bigelow's principle was that the stone should be crushed and wholly removed at one sitting under all conditions, he being persuaded that the danger of crushing operations arose from the presence of rough fragments in the bladder, and that prolonged gentle and skilful manipulation of instruments for the purpose of crushing and evacuating risked far less, provided the bladder was absolutely freed from all débris. Otis of New York had already shown the feasibility and importance of using large instruments in the urethra in another connection, by demonstrating that its normal caliber was much greater than had been thought, and had in this respect prepared the way for the introduction of the large and powerful instruments of Bigelow, to be described presently. To put this principle into successful operation Bigelow devised new forms of instruments. The following are the changes in the lithotrite. The description of the operation of litholapaxy is taken largely from Cabot:[1]

Lithotrite.—In order to prevent impaction of the blades by the débris the female blade had formerly been fenestrated; the change made by Bigelow consisted in placing on the male blade a series of inclined planes (Figs. 146 and 147) between the angles of which the detritus is forced out laterally. The rim of the female blade is low to facilitate the escape of the débris. The tip of the female blade was given a peculiar form which rendered its passage through the urethra, and especially over prostatic enlargements, more easy.

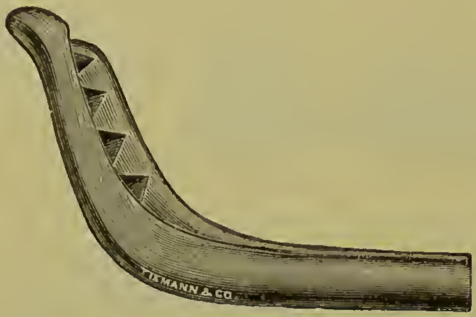

Fig. 146.—Beak of Bigelow's lithotrite (closed).

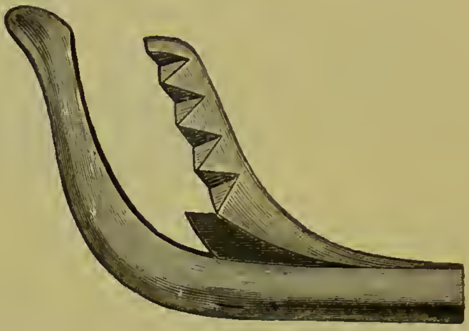

Fig. 147.—Beak of Bigelow's lithotrite (open).

The handle of the instrument was supplied with an ingenious mechanism which gives the important advantage to the surgeon of being able to lock and unlock the instrument without change of position of the hands, so that the alternate maneuvers of crushing by screwing and grasping fragments by sliding of the blades can be carried out with the greatest facility and accuracy and with the least waste of time. The shape of the handle is also much more convenient than that of preceding lithotrites (Figs. 148 and 149), as it enables the surgeon to grasp it more firmly and to work with more precision.

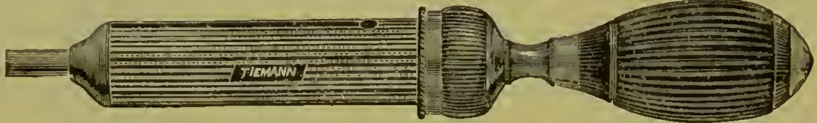

Fig. 148.—Handle of Bigelow's lithotrite (closed).

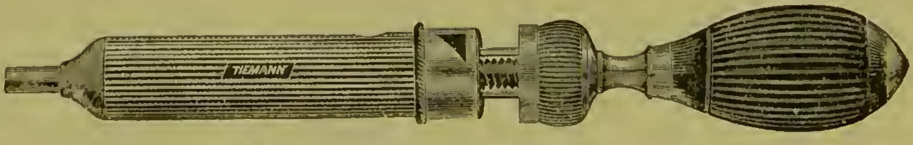

Fig. 149.—Handle of Bigelow's lithotrite (open).

The strength of the jaws is greater than that of other lithotrites, and the whole instrument more powerful, so that with the smaller sizes of the instrument stones of almost any degree of hardness can be crushed; for large, hard stones, however, the fenestrated blade is better, as it cuts through the stone more readily.

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[1] *Op. cit.*

Bigelow's lithotrites are made in three sizes, 25, 27, and 31 of the French scale, and for children in smaller sizes (16 French); the fenestrated blade in the latter size is better, because of the less risk of breaking the instrument.

The Evacuator.—The evacuator consists of a tube and elastic bulb, and a receptacle to receive the fragments. The catheter may be either curved or straight. The straight tube offers less resistance to the passage of the fragments, but is not so easy to pass as the curved one. The wing at the upper part of the tube acts as a guide to the position of its mouth in the bladder, and also facilitates the handling of the instrument. The fixed part of the tube connecting the catheter with the rubber bulb extends obliquely upward to the center of the bulb, and is provided with a stop-cock just outside the bulb, while the outer end of the catheter is also fitted with a stop-cock, the advantage of these being that the patient and bedding are kept dry while coupling and uncoupling the catheter and bulb.

The portion of the tube lying within the bulb is perforated with small holes, the total area of which exceeds that of the opening at the end of the tube. The return stream from the bladder brings the fragments which fall to the bottom of the receptacle beneath the rubber bulb, the perforated part of the tube permitting the passage of the inflowing current of water, but preventing the return of the stone fragments. If the stone be a large one, the glass receiver will be filled with the débris before the operation is completed, and will require to be emptied: the bayonet catch by which the receiver is attached to the bulb allows of this being done very readily. When it is desired to refill the bulb with water, it is easily done by means of the rubber hose which is attached to the top of the bulb, its other end being immersed in the water to be sucked into the bulb; this hose also provides for the expulsion of air from the apparatus and the easy regulation of the amount of water in the bulb and bladder during evacuation—a matter of great import-

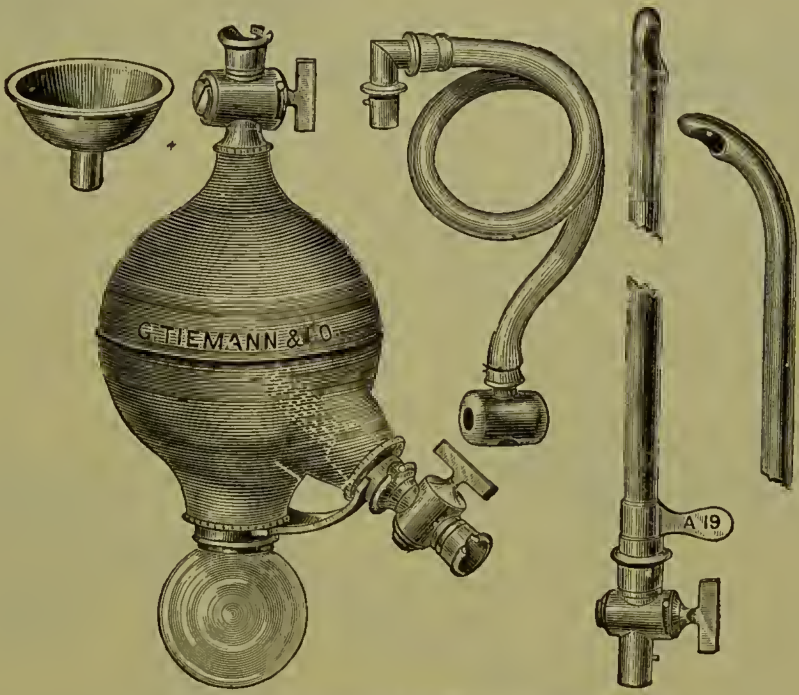

FIG. 150.—Bigelow's latest evacuator.

ance, as an over-tense bladder is a source of danger and must be at once relieved, while an empty one interferes greatly with the operation, as the lax walls are drawn into and obstruct the mouth of the tube.

In Bigelow's evacuator, as will be seen, the receiver in which the fragments are caught is at the farthermost point of the apparatus from the bladder, and the fragments, once received in it, cannot be again put in circulation and returned to the bladder (Fig. 150). In Thompson's, Guyon's, and Otis's instruments, on the other hand, the trap is between the bulb and the bladder—the return of the fragments in Thompson's evacuator by a perforated valve at the end of the tube. In both the others there are no valves, the force of gravity being relied upon to separate the débris from the water, the direction of the current assisting in this result (Figs. 150, 151, and 152).

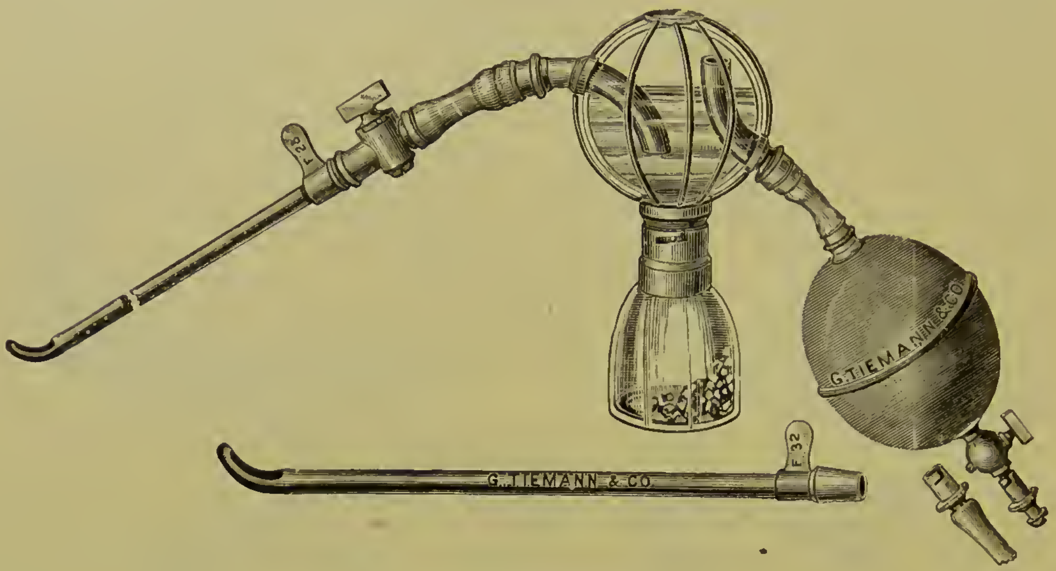

FIG. 151.—Otis's evacuator.

Numerous modifications and a great variety of models of evacuators have followed Bigelow's original instrument, but there has been little or no advance made in this direction, in the writer's belief, since the author of modern lithotrity issued his later instruments, lithotrites and evacuators, though of course any special form of instrument may be found to be more convenient by its inventor.

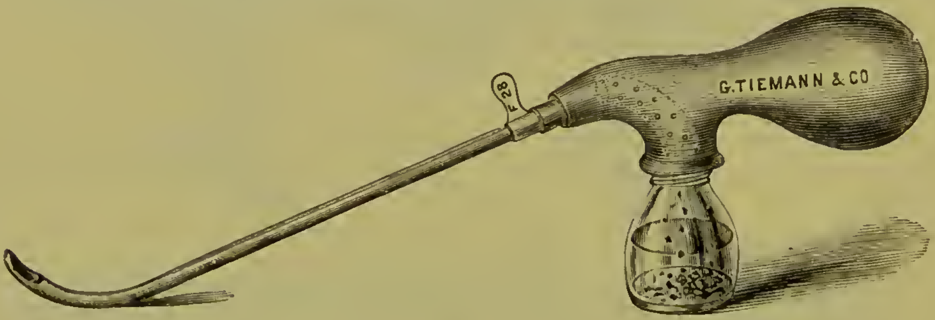

FIG. 152.—Chismore's evacuator.

A somewhat decided innovation was suggested by Dr. O. K. Newell of Boston in 1891, who called attention to the fact that if the penis in its pendulous portion was compressed upon itself, so as to shorten that part of it, the distance from the meatus to the bladder was reduced to between four and six inches: upon this he rested the assertion that the evacuating tubes and all the lithotrites then in use, including Bigelow's, were too long. The advantage claimed for the shorter tubes was that they would evacuate the débris more rapidly. Dr. Newell demonstrated the feasibility of their use, and the writer has found in practice that they are often of value: it is a mistake, however, to suppose that they are suitable to all cases; they are totally inadequate in the presence of any considerable hypertrophy of the prostate, for they cannot be made to reach the bladder because of the elongation of the deep urethra so commonly associated with that condition. The form of the tip of the tube proposed by Newell is not only of no advantage, but is a dangerous one to use even in skilled hands. The two-way cock between the bulb and the catheter is, in the writer's opinion, a most convenient one, and a decided improvement upon any of the previous forms. Newell's instrument has the further advantage of being very light, a desirable feature when the operation is a long one, as it spares the surgeon's hand much fatigue, and consequently gives it more delicacy and precision. Its weight is 9¼ ounces.

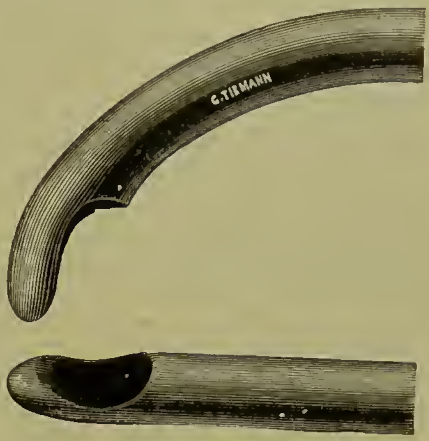

FIG. 153.—Ends of evacuating-tubes.

The form of the tip of Bigelow's evacuating-tubes is rounded, so that they can be passed through the deep urethra with the least possible risk of injuring it, and the mouth of the tube is so constructed that it receives and directs into the tube the fragments and allows the passage of those of large size (Figs. 151 and 152).

Keyes has introduced a straight tube with an open mouth and fitted with an obturator to free the end from fragments if they become impacted in it (Figs. 153 and 154).

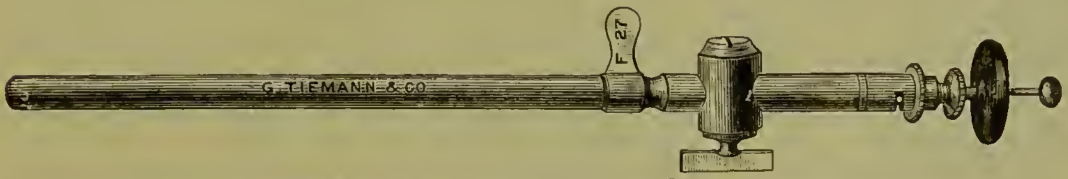

FIG. 154.—Keyes' straight evacuating-tube, with obturator.

Bigelow's Operation of Litholapaxy.—Small stones can ordinarily be crushed and pumped out without causing much pain, so that, in a patient who is not especially sensitive or whose urethra is accustomed to the passage of instruments, no anesthetic may be required or cocaine anesthesia can be employed, a 2 per cent. solution being ordinarily sufficient. This may be injected without fear of toxic effects. The pain of the operation may be decidedly diminished by the application of cocaine to the bladder and urethra, and in this way many stones have been crushed without resorting to general anesthesia. If cocaine is employed, it should be thoroughly applied in a 2 to 4 per cent. solution, the bladder having been previously emptied and washed out. In order to reach all parts of the vesical cavity it must be injected in considerable quantity, and there is, therefore, some danger of toxic effect, especially if the bladder is ulcerated and presents an absorbing surface.

Usually, except in the most trivial cases, it is best to do the operation under general anesthesia, for the relaxation of complete insensibility makes the manipulations much easier and adds greatly to the quickness and thoroughness of the operation. Especially is it important to allay the tendency of the bladder to spasmodic contractions, for not only does this force the water out alongside of the instruments, and so reduces the size of the cavity when room within it is necessary, but it subjects the bladder-walls to a dangerous strain, which, if the urethra is blocked, may lead to their rupture.

The patient, then, being thoroughly anesthetized and the presence of a stone having been established, a large sound may be passed to make sure that there is no stricture or other obstruction in the urethra. If a stricture is found, it may be rapidly dilated with large sounds or divulsed. A narrow meatus is to be cut. The urine should then be drawn with a catheter, the bladder should be washed out, and borax-water or a solution of boracic acid should be introduced in sufficient quantity to distend it, and so keep its walls out of harm's way during the crushing of the stone. From four to six ounces is usually a proper quantity. An elastic rubber tube may then be tied lightly around the penis, close to the corona glandis, to prevent the escape of water alongside of the instrument. This fills the double purpose of keeping a known quantity of water in the bladder and of preventing the wetting of the patient and the bed.

Before each introduction of the instrument the urethra should be filled with liquid vaseline from a syringe, in order to lessen the injurious friction as far as possible.

To introduce the lithotrite properly, the point should be carried with considerable gentleness through the constriction made by the rubber tube, and it then slips without difficulty through the movable urethra. After the beak passes below the pubes the handle should be brought to a vertical position, and the instrument will then drop almost without assistance, by its own weight, until the point rests just in front of the triangular ligament. Traction upon the penis now effaces the depression made by the extremity of the instrument in the bulbous urethra, and if the handle is then brought down gently between the thighs, and at the same time the point is advanced in the axis of the body, the lithotrite usually slips easily into the bladder.

The places where difficulty may be met with in a normal urethra are at the triangular ligament and at the prostate.

The point of the instrument may catch on the upper or lower edge of the comparatively rigid opening of the triangular ligament. If the handle is depressed before the beak of the instrument is carried down as far as it will go toward the rectum, the point is likely to catch against the upper edge of this opening; while, on the other hand, if the instrument is pushed too forcibly toward the sacrum, the lax bulbous urethra is depressed below the aperture and the point catches on the lower margin. Practically, if the instrument catches at the triangular ligament, it should be passed down with the beak hugging first the roof and then the floor of the urethra, and in one or the other of these ways it will usually find its way through. The finger pressing against the convexity of the curve of the instrument in the perineum will often lift the point over the lower margin of the opening when it is catching there.

A similar difficulty may be met with at the opening into the prostate. This happens but rarely, and is to be overcome by the same tactics. In cases of much difficulty the finger introduced into the rectum serves as a good guide, and with it the point of the instrument may be lifted into the prostate when it is catching on the lower edge. An enlarged prostate is, as a rule, easily passed by the lithotrite, whose short curved beak carries the point along the roof of the canal, where it rarely meets an obstacle.[1]

False passages may make the introduction of instruments extremely difficult and dangerous. Even if by long and patient trial they are finally passed and the stone is comminuted and removed, the danger is not then over, for a serious swelling of the urethra is likely to follow, and under these circumstances the passage of a catheter is almost an impossibility.

A single false passage, if its position is accurately made out, may usually be avoided by carrying the instruments along the opposite wall of the urethra at this point. If, however, several of these pockets exist, in which the instruments are caught, it will perhaps be a wiser plan to resort to lithotomy, which, though a more severe operation, has the great advantage of providing certain drainage for the bladder.

If the stone is free, it rests upon the floor of the bladder, and, with the patient in a horizontal position, it is usually found at a point a short distance behind the prostate.

The operation of crushing not only demands considerable skill of manipulation, but it is also greatly assisted by an accurate knowledge of the contour of the bladder, and of the changes in shape which may be impressed upon it by varying conditions of the surrounding organs.

Dr. Bigelow, in preparing his work on litholapaxy, made a careful study of these changes. He says: “‘We get a useful view of the interior of the bladder by examining in position through an opening in its summit. This part of the organ, with the free and thin posterior wall, is mainly concerned in distention. The floor of the bladder is comparatively firm and flat, and, if the subject is in good condition, adheres to a thick mass of cellular tissue in and near the ischio-rectal fossæ, upon which it rests. This mass is traversed by the rectum variously distended; and this canal in a thin subject may be advantageously filled with air during an operation, to facilitate its indentation by an instrument—reversing, for the operation of lithotrity, one of the precepts of lithotomy.

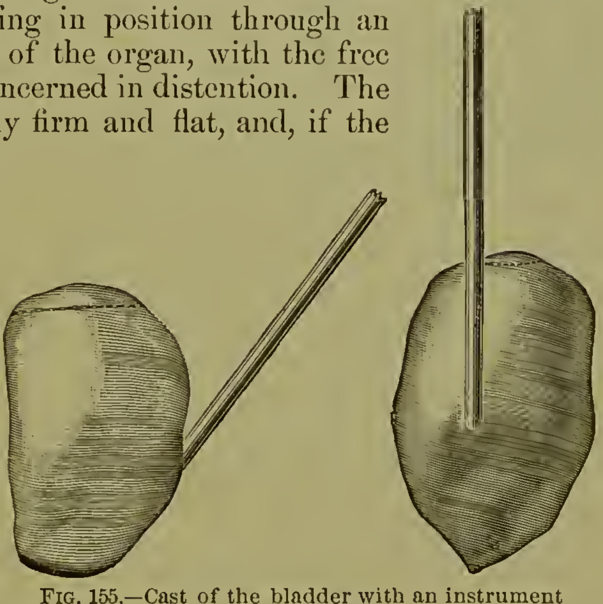

FIG. 155.—Cast of the bladder with an instrument depressing the floor.

“The sigmoid flexure is largely concerned in compressing the bladder behind. The posterior wall of this viscus may be so crowded by the intestines as to become flat or even concave. A horizontal section of the bladder is then transversely oval, flattened between the intestines behind and the pubes in front, each of these indenting it. A well-filled or tense abdomen tends so to shorten the antero-posterio diameter of the bladder that, while a large stone may gravitate backward into that part of the bladder that is compressed by the intestines, carrying the thin wall with it, it is not so with a fragment, which, unless the floor be artificially depressed, may lie on one side or the other of the vesical orifice more readily than at some distance behind it."

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[1] Great care should be exercised in passing the instrument through the prostatic urethra, for it is here that the greatest danger of making a false passage occurs, especially if prostatic hypertrophy exists; and, in the writer's experience, injury to the deep urethra is the most serious accident that is at all likely to occur during the operation.

A rectum filled with feces raises and distorts the floor of the bladder, and so not only-makes the search for a stone more difficult, but by resisting the indenting of the floor with instruments adds greatly to the difficulty of crushing. It is for this reason that the bowels should be thoroughly emptied before the operation.

If now the lithotrite be introduced and carried to the bottom of the bladder, its beak will make an indentation in which it will rest. Fig. 155 represents a plaster cast of the bladder with an instrument in this position.

As the stone rolls to the bottom of this funnel-shaped depression it rests on or alongside of the beak, and when the blades are opened it falls over the shoe or female blade, and is therefore seized as the male blade is again closed down.

If this maneuver does not succeed in catching the stone, the blades should be opened in the upright position and then turned over on one side and shut along the floor. Care should be taken to always open the instrument in the upright position, for if it is turned on the side and then opened, the male blade pushes the stone or fragments away, and they are not caught as it is again closed.

If the stone cannot be seized, it may be because it lies in the pouch behind an enlarged prostate, so that the instrument enters the bladder over it. In this case it may be caught by opening the instrument and then turning the blades over so that they point down into the base of the bladder, and shutting them in that position. There is some danger in nipping the bladder-wall by this maneuver, and an easier way of obviating the difficulty is by raising the hips of the patient. This change of position usually rolls the stone out of the post-prostatic pocket into a part of the bladder where it can be easily reached and crushed in the ordinary manner.

When, as rarely happens, the stone is so held in the pouch behind the prostate as not to be easily rolled back, it may usually be displaced by using the closed blades of the lithotrite to pry it out. If this is not successful, it can be pushed up by a finger introduced into the rectum, and if it tends constantly to fall back to a point where it is not accessible, the post-prostatic depression may be effaced by a distended rubber colpeurynter in the rectum, as suggested by Buckston Browne. Mr. Browne met with several cases in which the post-prostatic pocket was a veritable diverticulum beneath an enlarged third lobe, and so concealed the stone that it required a suprabubic operation for its removal.

A stone may be too large to fall into the depression of the instrument, and it is then necessary to depress the handle and so raise the blades before it can be seized. This sensation of having the stone above the sound or lithotrite sometimes leads to the belief that it is attached to the upper bladder-wall, when this is not the fact. In such a case, after the first crushing, the fragments, as they are reduced in size, will be found on the floor of the bladder.

The crushing of the stone should be done as thoroughly as possible at the first introduction of the lithotrite. This saves time and irritation to the urethra, and, with the self-clearing instruments described above, may be accomplished by a little skill and patience in searching for fragments. If the stone is a large one, however, sand and small fragments will presently accumulate and fill up the bottom of the bladder, and then the large fragments lying on top of this débris can no longer fall by gravity into the jaws, and they are then not easy to find. When this is found to be the case, it is time to use the pump and clear the bladder of the finer portions. The presence of clotted blood or of thick mucus in the bladder has a similar effect in filling up the depression upon the floor and preventing the fragments from falling into the jaws of the lithotrite. Here, again, the pump is called for.

The form of the female blade, with projecting end and width enough to carry its sharp rim away from close contact with the male blade, makes the nipping of the bladder-wall unlikely to occur. This accident is so serious that it should be further guarded against by always, in case of doubt, carrying the blades toward the center of the bladder and slightly rotating them from side to side, to see if they are free, before they are screwed down upon anything that has been seized.

Practically, with the Bigelow instrument, having a floor to the female blade, operating in a moderately distended bladder, the jaws may be safely pressed down toward the trigone, and then opened and shut without any fear of catching the bladder-wall so long as they are kept nearly upright. This maneuver is a valuable one in rapidly reducing the fragments of a soft stone, for no screw-force is required, and the fragments, constantly falling on to the female blade, are comminuted as rapidly as the instrument can be opened and shut.

It must be remembered, however, that if the bladder is so empty as to fall into folds, greater care must be exercised; and also that, if the instrument is turned toward the side wall, it may perhaps catch a fold, and should be closed with caution. A nip from the blade of a non-fenestrated lithotrite does not necessarily produce a serious lesion of the bladder-walls. This accident occasionally happens to every operator without causing troublesome after-effects. But the fenestrated instrument with its scissor-like blades, if shut down closely, cuts out the piece of the bladder-wall included within its jaws. Especial care should therefore be used in the manipulation of this instrument.

There is also another peculiarity in the working of a fenestrated lithotrite which should be borne in mind when one is used. It is this: During the early part of the crushing, when the stone breaks and falls apart in the jaws, it is natural to open the lock and again search for a large fragment without fully screwing down. This is a safe maneuver with a solid instrument, but with a fenestrated one it is important to remember that portions of stone pushed through the female blade will cling to it with some tenacity unless the male blade is thoroughly pushed down through it, and that a rough fragment thus projecting below the blades may do serious injury. Therefore the fenestrated instrument should always be closely shut down on whatever it seizes.

When, finally, no more fragments of any size can be caught, the lithotrite should be firmly screwed together and withdrawn. If there is any difficulty in fully closing it, the jaws may be carried to the center of the bladder, and there with the screw may be opened and shut a few times to work out the impacted stone from between them. This maneuver is of importance, not only on account of the difficulty of drawing out a partially open instrument, but far more because an instrument not wholly freed of débris may have sharp, angular fragments projecting from it which will lacerate the urethra in withdrawal.

We now come to the second part of the operation, the evacuating of the fragments. In selecting the catheter for this a straight tube should be used, if possible, as it not only affords a straighter and easier road for the fragments, but also is more easily turned in the bladder when the operator wishes to direct the orifice toward different portions of the viscus.

While the curved tubes are introduced like an ordinary catheter, the straight tube requires a little manipulation. It should be carried down in a vertical direction until it will go no farther toward the rectum. Then, being brought to a horizontal position, it should be gently pushed upward in the axis of the body. At the moment of bringing the tube down between the thighs pressure should be made over the pubes, pushing the penis downward in order to relax the suspensory ligament. Before advancing the instrument horizontally it is well to withdraw it very slightly in order to disengage its point from the pocket which it is likely to make in the bulbous urethra. When there is a hitch at the triangular ligament or at the prostate, the tube may usually be carried through by rotation in the manner of a corkscrew. As all the obstacles likely to be met in the urethra are on the floor, it is usually sufficient to carry the outer end of the straight tube low down between the thighs in order to enable its point to ride over any obstruction that it meets in the prostate. With care in these regards it passes readily into the bladder. When, owing to any peculiarity of the urethra or prostate, the straight tube does not pass readily, a tube with the point slightly turned up, after the manner of a coudé catheter, may be tried, and if this fails the curved tube may be used as a last choice.

When the tube has entered the bladder its point should be carried gently down toward the base, and it should then be connected with the bulb. On opening communication between them the air contained in the tube will escape into the bulb, and should be driven out through the hose at the top, and its place supplied by water before the operation begins.

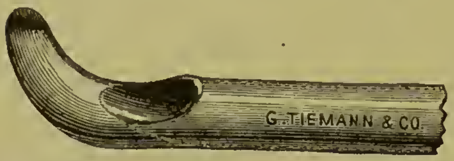

FIG. 156.—Straight tube, with the end turned up to facilitate introduction.

When there is much débris, it is well to commence pumping with the point of the tube held a little above the floor of the bladder. During this earlier part of the operation there should be no interval between the compression and expansion of the bulb. The object at this time is to set the fragments whirling, and to catch them while they are suspended. If the end of the tube is buried too deeply in the detritus, it is apt to be clogged at the outset, and the evacuation is thereby considerably hindered. Later, when the fragments are few, the tube is carried to the floor of the bladder, and a few moments should elapse, after pressing the bulb, to give the fragments time to settle into the depression about the end of the tube before the expansion which is to suck them into it. When any particular aspiration brings fragments, the position of the tube should be kept unchanged until they cease to come.

The wedging of a fragment in the tube causes an obstruction which is very noticeable. The compression of the bulb is rendered difficult and its expansion slow. An angular fragment may lodge so that, while it allows the passage of water, it prevents the entrance of other fragments. This condition may be suspected if there is a constant clicking against the tube and still nothing appears in the reservoir. The usual point where fragments wedge is at the mouth of the tube. When one thus becomes fixed, it may be dislodged with a stylet, and this is the safest method of disposing of it, although with care the tube may generally be drawn out with the fragment in it. This procedure, however, is not devoid of danger, for sharp, projecting angles may lacerate the urethra or a bit of stone may remain sticking in the passage.

The tube may also be obstructed by the bladder-wall, which is sometimes sucked into the orifice. The stoppage from this cause is usually not continuous, but the walls flapping against the opening give the instrument a series of jerks which remind one of a fish-bite. When this is felt, the instrument should be moved to another part of the bladder; and, if it then occurs, it shows that the bladder is not sufficiently distended, and water should be added through the hose at the top of the bulb. Pumping should be prolonged until the sand and gravel cease to come. Then the lithotrite should be again introduced and the crushing continued, followed again, as before, by the washing out. Finally, after the stone has been thoroughly crushed, and when for several minutes no fragments appear in the reservoir, it is evident that the evacuation is almost completed; and now begins a very important part of the operation—namely, the search for the last fragments. The tube should be moved to different parts of the bladder, and the orifice should be systematically turned in all directions in order to wash out any side pockets or corners that have been passed over. The pouch behind the prostate should be especially attended to in this way.

Keyes recommends his tube with open end for the washing out of the last fragments. It requires especial care in its manipulation, and its vesical end must be kept close to the neck of the bladder. If introduced too far, it sucks up the posterior bladder-wall uncomfortably; and if drawn out too far, it may bruise the prostate.

It sometimes happens that the last fragment is difficult to find with the lithotrite, and is still a little too large to pass the tube. Great patience is then required in the search for it. I have once or twice succeeded in such a case by drawing the fragment to the tube, and have then dropped it on the floor of the bladder, where the lithotrite readily found it and crushed it.

Chismore has devised a lithotrite (Fig. 157), which seems admirable for the removal of this last fragment. In it the shaft of the male blade is hollow, the opening being in the heel of the blade. It has an aspirating bottle attached to its upper end, so that when the blades are slightly separated and suction is applied, the fragment is drawn between the jaws and easily crushed on closure of the instrument.

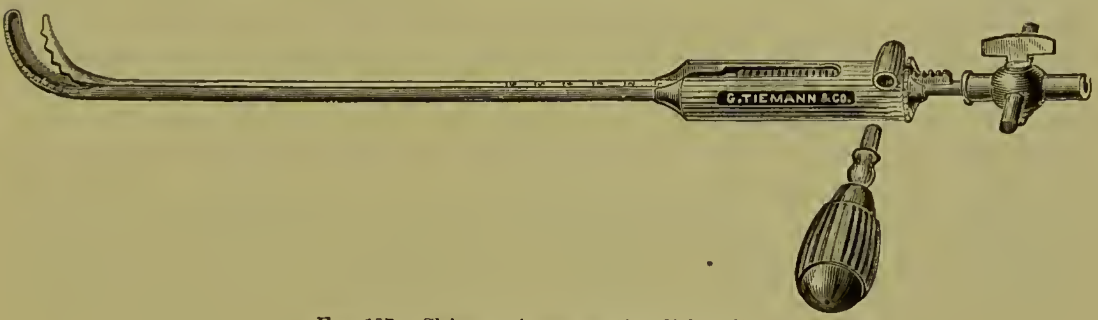

FIG. 157.—Chismore's evacuating lithotrite.

Finally, if after a careful search no more fragments can be obtained and no click of stone against the tube can be elicited, the operation is completed. Before closing, however, it is well to wash out the urethra thoroughly with a catheter of small size, which allows the water to rush out alongside of it. This removes much fine sand, which oozes along the lithotrite and lodges in the canal during the operation. The writer adopted this plan several years ago, and he has found, since putting it in practice, that his patients have suffered less from painful, scalding micturition than formerly.

After-treatment.—If the patient has been able to urinate normally before the operation, little or no after-treatment is required. It is usually well to allow the patient to drink liberally of water, and to keep him quiet for a few days, although this is often not necessary where the stone is small and has not caused much cystitis. When, however, owing to enlargement of the prostate or stricture of the urethra, the bladder has not been able to empty itself, but requires the aid of a catheter, it is often well to fasten the catheter in for the first few days, and thus provide for the drainage of the bladder, and at the same time spare the urethra the irritation of the frequent passing of an instrument. This also may be required when there has been any laceration of the urethra which may lead to swelling and partial closure of the canal.

The cystitis which persists after the removal of the stone should be treated by medication, and, if necessary, by irrigation, as described elsewhere.

It sometimes happens that the bladder becomes partly filled with tenacious muco-pus which does not readily pass with the urine, and which leads to an almost constant desire to micturate, with a sometimes painful tenesmus. This can usually be drawn off through a large, soft catheter, but if this does not succeed, it may require the use of a litholapaxy-pump for its removal.

At the end of ten days or a fortnight the bladder should be washed out with an evacuator to remove any sand or gravel that was left at the time of the operation, and which would serve as a nucleus of a new stone. In a sacculated bladder or where there was much mucus present at the time of the operation fragments will often be found by the secondary pumping, and in some cases the tendency to the formation of phosphatic material is so strong that repeated pumpings at intervals of ten days will continue to remove little calculi until the alkaline tendency of the urine has been overcome.

The operator should not be content until he has had a satisfactory washing with the pump without obtaining calcareous material. As a small catheter can be used for the removal of this fine débris, the operation is comparatively free from pain and can be done without anesthesia.

The operation as just described is the litholapaxy of Bigelow, and it remains to speak of one or two variations of it practised by good operators and liked by them. The changes introduced are mainly in the methods of accomplishing evacuation :

Chismore's evacuating lithotrite has been described, and its usefulness in the search for the last fragment alluded to. It was originally devised for this purpose, but its inventor has gradually pushed his use of it until now he employs it in all his operations from beginning to end. The light rubber aspirator that he has attached to it does not interfere with its manipulation as a lithotrite, and does not have to be removed during the crushing of a soft stone. When more power is needed in the crushing the aspirator is removed and a handle is substituted, which gives a firmer hold and permits of the exercise of more force. When the stone is very hard he uses an extra strong male blade with a lock and screw.

Some operators use the elasticity of the bladder-walls to accomplish the evacuation of the fragments. Guyon introduces the evacuating catheter and lets the fluid in the bladder rush out, bringing what fragments it can with it. He then with a syringe fills the bladder, and again empties it with a rush. After repeating this a number of times and removing as much as possible, he then uses the aspirator to pump out the last fragments.

Keith has recently reported satisfactory results obtained without the use of any aspirator whatever, and seems to have removed many large stones simply by filling and emptying the bladder. He speaks of no cases of rupture of the bladder due to the forcible injection. His practice has been in India, and possibly his patients have been somewhat younger than is the rule among stone-patients in other countries. This would account for his finding sufficient resiliency in their bladders to accomplish evacuation in this fashion. Among old patients with atonied bladders it would not seem possible to expect such results.

I have tried this method in a somewhat modified form after a manner proposed by Dr. F. H. Williams a number of years ago. By means of a two-way cock attached to the end of the catheter it was arranged so that water could be at will run into the bladder, and then run out through a tube over the side of the table. In this way we had a siphon action drawing the fragments from the bladder, in addition to the elasticity of the bladder driving them. The injection of water into the bladder was provided for by a tube connected with the upper opening in the two-way cock and joining it with a raised reservoir. This reservoir was a transparent graduated glass, and thus at each filling of the bladder the operator could see exactly how much water had flowed in, and could judge of the tension by noticing the rapidity of the fall of water in the reservoir. The apparatus was easily and quickly worked by alternately turning the current to and from the bladder.

In the case upon which this was tried the amount of débris was great, and the bladder was dilated and atonied. The clogging of the tube was troublesome, and the outrush was not forcible enough to carry the detritus along in any large amount. After trying this method for a time I substituted the Bigelow evacuator, with the result of a greatly increased rapidity in the removal of the fragments.

Complications which may Arise during Litholapaxy.—Among the accidental conditions which may arise during a litholapaxy may be numbered the following: Hemorrhage, laceration of the urethra, injury of the bladder-walls, impaction of a fragment in the urethra, and clogging, bending, or breaking of the lithotrite.

Hemorrhage.—A slight or moderate amount of bleeding not uncommonly accompanies the operation. It may come from the urethra or bladder. More commonly it is due to the injury done to the congested prostatic urethra, and it is more likely, therefore, to be seen in old men. When the blood comes from the urethra anterior to the prostate, it rarely causes any trouble, and soon ceases. Blood from the prostate runs back into the bladder, and, clotting there, may interfere with the crushing of the stone. It is readily sucked out through the evacuating tubes of ordinary size, and the bleeding usually ceases or diminishes after the first few minutes. If it continues to be troublesome, the injection of hot water (115° F.) may be tried.

The bladder-walls rarely bleed much unless seriously diseased or injured. A hemorrhage of any amount in the vesical cavity leads, therefore, to a strong suspicion of the existence of a tumor, and in such a case the washings from the bladder should be carefully saved and examined for bits of new growth. If these were detached and recognized during the operation, the plan of procedure would naturally be changed and a suprapubic incision would be resorted to. Keyes mentions one case in which, in a bladder not containing a tumor, the loss of blood was so great as to lead to the temporary abandonment of the operation. Subsequently, when the fragments remaining were washed out, there was very little hemorrhage.

In patients of a hemorrhagic diathesis the operation would naturally be approached with a good deal of hesitancy, but I have seen no account of serious trouble from this cause.

Laceration of the urethra may be caused either by the introduction of the instruments or by the withdrawal of them when clogged with projecting sharp fragments. In skilful hands an uninjured urethra ought not to be torn during the introduction of instruments of a proper size. An ulcerated or partly strictured canal may be torn even when due care is exercised. It is a good safeguard against this accident to pass a conical steel sound one or two sizes larger than the lithotrite and tubes. This gently stretches the canal, so that the rougher, pointed instruments are afterward less likely to catch. In the event of having troublesome false passages, either pre-existing or made at the time of the operation, the surgeon may wisely decide to change the plan and do a lithotomy.

The withdrawal of a clogged lithotrite or of a tube holding an impacted fragment may considerably lacerate the urethra. When this occurs the ragged tear offers a favorable surface for septic or urinary infiltration, and this accident adds, therefore, considerably to the danger of the operation. This danger is lessened if the urethra is thoroughly washed out with an aseptic solution at the end of the operation.

Whenever so much injury of the urethra results as to lead to the fear of urinary absorption or of retention from swelling, it is well to fasten in a catheter for the first two or three days. This is especially desirable in a case requiring catheterization or when a long and tortuous prostatic urethra has been thus injured. Usually, with this precaution, lacerations of the urethra do not lead to serious consequences, especially if antiseptic precautions have been carefully observed in the instrumentation and if the urine has been rendered aseptic before the operation.

Injuries of the bladder may be caused by catching the walls in the lithotrite. This may usually be avoided by keeping the bladder moderately distended with water during the crushing, so as to prevent its wall from being thrown into folds which might be caught in the jaws of the instrument. The care in the use of the lithotrite which is necessary to avoid this accident has been described in considering the operation. It is conceivable that in a diverticulated or chambered bladder the female blade of the open instrument might find its way into a pocket or chamber, while the male blade remained in the general cavity, and the intermediate septum would then be caught as the instrument was closed. I have seen bladders in which this might have easily occurred, and have twice during litholapaxy in old men had my instrument so caught and held that I thought it must be thus held in a pocket; and finding, on trying to close it, that a soft resistance was met, I kept the blades partly open, and then, keeping the shaft nearly upright, carried the heel of the instrument close down behind the neck of the bladder, and thus was able to close it. In both cases by operating near the neck of the bladder I was able to finish the crushing and evacuation of the stone. Fortunately, injury of the bladder-walls by nipping is usually followed by no untoward results.

Another accident which may happen to the bladder-walls is the rupture of them during litholapaxy.

Rupture of the Bladder-walls.—This may result either from using the pump when the bladder is too full, or from spasmodic contraction of the bladder when the urethra is blocked with instruments. Great care should be taken, when injecting the bladder before the operation, to notice the degree of resistance which it offers to the entrance of the water. This is especially important if the escape of the water alongside of the instrument is prevented by an elastic band. The force required to rupture an undiseased bladder-wall is so great that this is very unlikely to occur; but, as many of these bladders are diverticulated in old people, there is considerable danger to the thin-walled diverticulum.

I have had one such case in which a bladder ruptured itself by its own spasmodic contraction when containing but an ounce or two of urine. In this case a laparotomy was done at once. It was found that the rupture had taken place extra-peritoneally on the left side, and the urine had escaped into the cellular tissue up toward the kidney on that side. Drainage was established in the left groin, and the case eventually got well.

Whenever, during litholapaxy, the bladder is affected by violent spasms, the operation should be delayed until the anesthesia is so profound as to put a stop to these. If this is found impossible, it may even be necessary to do a lithotomy rather than run the risk of rupture. When a spasm occurs during the pumping, it can be at once relieved by opening the stop-cock at the top of the bulb and letting out the excess of water.

Impaction of Fragments in the Urethra.—Occasionally, as has been said, fragments lodge firmly in the eye of the evacuating-tube, and the temptation is strong to try to draw them out with the tube. This attempt usually succeeds, but, besides its scratching the urethra, there is danger that the fragment may be dislodged from the tube and remain sticking in some part of the canal. Also, if the bladder is contracting strongly, a fragment may be forced into the urethra at the time of withdrawal of some of the instruments.

The points of usual arrest of fragments are in the prostate, at the triangular ligament, and just behind the meatus. From this last situation fragments are usually removed by incising the meatus and using forceps. A fragment lodged in the prostate may often be pushed back into the bladder with a large, blunt-pointed sound. When the bit of stone lodges in the urethra just anterior to the prostate, it may be very difficult of removal. In a recent case, where a fragment was dropped by the tube in the membranous urethra, I succeeded in pushing it back into the bladder by the following maneuver: Passing a straight tube with a long under lip down to the fragment, I then introduced the finger into the rectum, and, while lifting the bit of stone, worked the lip of the tube under it, so catching it in the mouth of the tube and readily pushing it back into the bladder.

Clogging and Breaking of the Lithotrite.—The strong modern lithotrites of the Bigelow pattern do not easily become clogged. A tough foreign body, as the nucleus of a stone, may, however, resist complete crushing and become entangled in their jaws. I have met one case in which a leather shoe-string formed the nucleus of a stone, and became so fixed in the jaws of the lithotrite as to make a very considerable mass to be drawn out with it. Though the urethra was much rasped by its passage, no ill effects followed. It is conceivable that in some such way the jaws of an instrument might be so held apart that they could not be withdrawn without great violence. Under such circumstances the blades should be carried to the center of the bladder, where there is no danger of catching the walls, and should there be many times opened and shut with the screw in order to gradually grind up or cut through the offending body.

If a lithotrite is tested outside of the bladder on a hard stone, it will be found that its blades are often twisted considerably during the crushing, but, being of well-tempered steel, they spring back into correct shape when the pressure is taken off. With a small instrument suitable for a child this twisting is often very great, and it may happen that the resistance of the metal is overcome and the jaws are so distorted as to be afterward difficult of withdrawal. Usually, however, they break rather than bend. A number of cases of this accident have been reported. The fracture may occur at the heel of one of the blades or on the shaft of the female blade a short distance above the bend.

This last point is the position of the greatest strain in crushing a large stone, for the obliquity of the blades causes the force against the female blade to act rather downward, so that there is greater leverage exerted upon the shaft above than at the heel of the blade. When a hard stone is encountered, which resists all the force that it seems safe to apply, it is best, after cutting into it somewhat in one diameter, to seize it in a new place. It thus presently becomes weakened and gives way.

The breaking or serious clogging of a lithotrite may oblige a resort to lithotomy. A perineal incision will usually give room enough for the extraction of a broken blade or for the clearing of a clogged instrument. If the perineum is very deep or the prostate large, the suprapubic route will probably be preferable, and in case of a twisted or distorted instrument the high operation gives more room for the exercise of force sufficient to bend the blades back into place.

Complications after Operation.—Hemorrhage rarely causes trouble after litholapaxy, except that in cases requiring the use of a catheter this may be plugged by the clots. It may be necessary to free the bladder by the evacuator if ordinary injections and irrigation fail to bring them away.

Epididymitis occasionally follows an operation in which the prostate has been much irritated. The only case in which I have seen epididymitis follow the operation was one in which the urethra was considerably scratched by a rough fragment which was drawn out in the eye of the evacuating-tube.

Urethritis, Prostatitis, and Cystitis.—Inflammation of the urethra, of the prostate, or of the bladder may follow a litholapaxy. In fact, such conditions existing before the operation may be temporarily aggravated by it. The treatment of them is considered in another part of this work, and does not require special attention here.

Urinary fever is a complication to be occasionally expected, especially in those cases in which the kidneys are greatly affected, and something has been already said in regard to the best prophylactic measures to be taken against it.

Phlebitis.—Rarely, an inflammation may extend from the small venous sinuses about the neck of the bladder to neighboring large trunks. I have had one case in which the left leg was swollen and tense from this cause. The patient was a middle-aged man, who made a good recovery from an operation for the removal of a hard uric-acid calculus of considerable size. Fourteen days afterward he was on the lounge, and the bladder was washed out with the pump without ether. This caused him rather more pain than usual, though no difficulty was experienced in the manipulation. A few hours later he was seized with severe pain in the left leg, which at once began to swell, and ran the ordinary course of a rather extended phlebitis of the femoral vein.

Treatment after Litholapaxy.—After an uncomplicated litholapaxy, in a case with reasonably sound urinary organs, the relief is often immediate and the recovery uneventful. It is well, however, even in such a case, to keep the patient quiet in bed for a few days, as the urinary organs are often slow to show inflammation, and a febrile condition may set in on the second or third day after a litholapaxy when up to that time everything has seemed to go smoothly.

Usually some pain and febrile reaction follows the operation. Hot applications to the hypogastrium and perineum will do something to relieve the pain. The treatment commenced before the operation to render the urine aseptic may be continued, and for a diuretic the free administration of spring-water is usually sufficient.

If there is a tendency to retention of urine and the bladder empties itself incompletely, the catheter must be used. Mucus and irritating ammoniacal urine must be removed by irrigation with appropriate solutions of borax, permanganate of potash, or nitrate of silver. If there is a tendency to phosphatic deposit, it must be met by injections of dilute nitric acid, and by the occasional use of the evacuator to remove granules too large to be destroyed by solvents.

Other complications must receive appropriate treatment

At the end of ten days or a fortnight, when the irritation caused by the operation has subsided, the evacuator should be used to make sure that there are no retained fragments or sand. At this time, after the mucus has largely disappeared from the urine, it is surprising how easily fragments are removed which escaped the most diligent search at the original operation.

In the *Lancet* of Sept. 22, 1888, Reginald Harrison describes his modification of Dolbeau's perineal lithotrity, as has already been noted, and again, in the *Lancet* of April 7, 1894, recurs to the subject, reporting 14 cases upon which he operated by this method with entire success, and refers to it as follows: "The name of perineal lithotrity was given in 1862 by Professor Dolbeau to an operation completed in one sitting, by which the membranous portion of the urethra is opened, the prostate and the neck of the bladder dilated instead of being cut, and a large stone crushed and its fragments immediately evacuated.

"The chief features about the operation I am about to describe are: (1) the mode of obtaining access to the interior of the bladder from the perineum; and (2) the mechanism connected with crushing and evacuating the stone. From a number of experiments I made on the dead subject, as well as from the performance of median cystotomy on the living for various purposes, it seemed unnecessary to do more than make an opening from the perineum into the membranous urethra at the apex of the prostate, on a grooved staff passed along the urethra, sufficient to admit the introduction of Wheelhouse's small tapering gorget, and subsequently the index finger, into the bladder, as for digital exploration or as is done in the boutonnière or Cock's operation: more than this is not necessary. In Dolbeau's operation direct access was obtained by this route, aided by the use of an expanding instrument, by means of which the prostatic urethra and neck of the bladder were dilated. It seemed to me, from some experiments made on the cadaver, that the latter means of dilatation was not only unnecessary, but was open to the objection that, unless used with the greatest care, it was possible to inflict serious damage. Further, I succeeded in demonstrating that by means of crushing-forceps, shaped somewhat like the blades of the lithotrite, and not exceeding by actual measurement in circumference that of an ordinary index finger, sufficient power might be provided to crush and assist in evacuating any stone that would be fairly seized in this way. These forceps are provided with a cutting rib within the blades, and the more powerful instruments are fitted with a movable screw on the handle. The fragments may subsequently be withdrawn by means of aspirator-catheters passed through the wound, or even by forceps. If care is taken to make the perineal wound correspond in size with the evacuating catheters, which should be of about the size of an ordinary index finger, there is no difficulty in keeping the bladder distended during the necessary manipulations. The chief points in favor of this operation are these: (1) it enables the operator to crush and evacuate large stones in a short space of time; (2) it is attended with a very small risk to life as compared with other operations where any cutting is done, such as lateral or suprapubic lithotomy, and is well adapted to old and feeble subjects; (3) it permits the operator to wash out the bladder and any pouches connected with it more effectually than by the urethra, as the route is shorter and the evacuating catheters employed are of much larger caliber; (4) the surgeon can usually ascertain, either by exploration with the finger or by the introduction of forceps into the bladder, that the viscus is cleared of all débris; (5) it enables the surgeon to deal with certain forms of prostatic outgrowth and obstruction, complicated with atony of the bladder, in such a way as not only to facilitate the removal of the stone, but the restoration of the function of micturition; (6) by the subsequent introduction and temporary retention of a soft-rubber drainage-tube states of cystitis due to the retention of urine in pouches and depressions in the bladder-wall are either entirely cured or are permanently improved. To lock up unhealthy ammoniacal urine in a bladder that cannot properly empty itself after a lithotrity is to court the formation or recurrence of a phosphatic stone. Hence it is well suited to some cases of recurrent calculus. I have never known the wound to remain unhealed, except in those instances where, for some reason or other, it has been desired to construct a low-level urethra, as in an instance I have recorded elsewhere. It is well adapted for some cases of stone in the bladder complicated with stricture in the deep urethra, as it enables the surgeon to deal with both at the same time. Nor does it expose the patient to the risk which may be attendant where lithotrity is performed with a weakened or permanently damaged urethra."

Choice of Operation.—No single operative method is applicable to all cases of stone. Each case presents its own special conditions on which the surgeon will base his decision, but, although the conclusions reached by different operators will vary somewhat, there is in the main a fairly general agreement as to the choice of operation.

It would take too much space to follow the numerous discussions of various writers on this subject; the author therefore begs leave to present briefly the more important factors which, in his opinion, determine the choice of method. These arrange themselves as follows:

I. Mortality;
II. Permanency of results;
III. Injury done to the parts;
IV. The presence of complicating disease;
V. The condition of the bladder and urethra;
VI. Size and consistency of the stone (foreign bodies);
VII. The relative proficiency of the operator in the different methods;
VIII. The duration of anesthesia.

The *mortality* of all stone operations increases with each decade after puberty, and is much greater after fifty years of age and least under fourteen, as will be seen from the three following tables and estimates from various sources, taken from a compilation by Cabot in 1893:

Suprapubic Lithotomy.

Operator or reporter.	Children.				Adults.				Old men.			
	No. of cases.	Recovered.	Died.	Mortality.	No. of cases.	Recovered.	Died.	Mortality.	No. of cases.	Recovered.	Died.	Mortality.
König	. .	. .	. .	. .	1	1	. .	. .	4	. .	4	
Werewkin	24	17	7									
Assendelft	78	76	2	. .	24	24						
Cabot	. .	. .	. .	. .	1	1						
Tremaine	1	1	. .	. .	1	1	. .	. .	1	1		
Thompson	. .	. .	. .	. .	. .	. .	. .	. .	6	5	1	
Guyon	. .	. .	. .	. .	. .	. .	. .	. .	8	5	3	
Mikulicz	3	2	1									
Walker	3	3										
Garcia	43	37	6									
Recent foreign	55	42	13									
Recent British	33	33										
Total	240	211	29	12%	27	27	. .	0%	19	11	8	42.1

Garcia, from a collection of 106 cases of all ages, calculates a death-rate of 24.4 per cent.; Tuffier, from 120 cases without regard to age, has a death-rate of 27 per cent.; Dulles found among 231 adults a mortality of 32.4 per cent., while among 132 children there was a death-rate of 21 per cent.

Litholapaxy.

Operator or reporter.	Children.				Adults.				Old men.			
	No. of cases.	Recovered.	Died.	Mortality.	No. of cases.	Recovered.	Died.	Mortality.	No. of cases.	Recovered.	Died.	Mortality.
Freyer	. .	. .	. .	. .	81	77	4	. .	69	68	1	
Keegan	114	110	4									
Van der Veer	. .	. .	. .	. .	10	8	2	. .	11	8	3	
Kerr	. .	. .	. .	. .	15	15	. .	. .	7	7		
Cabot[1]	. .	. .	. .	. .	9	9	. .	. .	33	31	2	
Mass. General Hospital	1	1	. .	. .	34	32	2	. .	68	57	9	
Total	115	111	4	3.5%	149	141	8	5.3%	188	173	15	8%

Guyon had a mortality of 5.2 per cent. in 647 cases of all ages; Usigli calculates a mortality of 4 per cent.; while Tuffier places it at only 3 per cent.

Perineal Lithotomy.

Operator or reporter.	Children.				Adults.				Old men.			
	No. of cases.	Recovered.	Died.	Mortality.	No. of cases.	Recovered.	Died.	Mortality.	No. of cases.	Recovered.	Died.	Mortality.
Freyer	143	143										
Werewkin[2]	147	138	9									
Cabot	3	3	. .	. .	. .	. .	. .	. .	1	. .	1	
Mass. General Hospital	16	16	. .	. .	2	2	. .	. .	1	. .	1	
Carrow	46	44	2	. .	76	71	5	. .	14	13	1	
Rivington	. .	. .	. .	. .	1	. .	1	. .	3	3		
Total	355	344	11	3.1%	79	73	6	7.6%	19	16	3	15.7%

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[1] One from bronchitis and pneumonia.

[2] Seven fistulæ.

Freyer gives the following rates of mortality after lateral lithotomy, arranged according to age; they are calculated from 987 cases occurring during the year 1883 in the Northwest Provinces of India:

Rate of mortality up to 20 years	5.1 per cent.
" " " from 20 to 40 years	10.7 " "
" " " above 40 "	31.9 " "

Rosenthal, from a collection of 400 cases, deduces the following rates:

Mortality from 1 to 5 years	3.5 per cent.
" " 6 to 11 "	2.1 " "
" " 12 to 16 "	8.4 " "
" " 17 to 29 "	15.7 " "
" " 30 to 66 "	38.8 " "

From these statistics we see that *in childhood*, judging the results as to mortality only, there is little to choose between lateral lithotomy and litholapaxy. The death-rate in each is but little over 3 per cent. Suprapubic lithotomy is more dangerous, with a death-rate of about 10 per cent. In adult life the death-rates alter somewhat in favor of litholapaxy. As the prostate and urethra enlarge, and the parts about the neck of the bladder become more vascular, the dangers incident to cutting through them increase. On the other hand, the increase in the size of the parts makes the performance of litholapaxy comparatively easy and safe. Suprapubic lithotomy keeps its place as a more dangerous operation than either.

The safety of median perineal lithotrity, already described, is shown by the experience of Brig. Surgeon J. Forbes Keith of Delhi, India, which will be given later in his own words.

Chismore's remarkable series of 54 cases without a death in patients over fifty years of age, upon whom he operated by a modification of the old method of lithotrity in repeated short sittings, calls for special attention.

Chismore's method differs from the old way of doing lithotrity by short sittings in that he employs cocaine anesthesia, and limits the time of each sitting only by the occurrence of any grave symptom, such as exhaustion, bleeding of importance, faintness, etc. As the writer said, after hearing Dr. Chismore's paper in Washington in 1893: "This series of wholly successful cases in elderly men is too striking to be ignored, even though it is in direct contradiction to the unanimous verdict established by the adoption of Bigelow's litholapaxy and abandonment of the old method of repeated short sittings. Chismore's results are not enough to make us turn back from the new lithotrity, but they are certainly suggestive. The absence of general anesthesia seems to be the element by which to explain this remarkable series of successful cases.

The rate of mortality in old age is overwhelmingly in favor of litholapaxy. While the danger attending all the cutting operations is increased very greatly, the mortality after crushing is very little higher than it is earlier in life. The fourth table and remarks are from a paper by Brig. Surgeon J. Forbes Keith of Delhi, India,[1] entitled "The Complete Abandonment of the Cutting Operations," and has for its chief object the advocacy of perineal litholapaxy, which, as stated, Harrison had already urged in 1888. Forbes Keith, however, introduces a radical modification with regard to the evacuation of the fragments: he proposes to do away in most instances with the evacuating pump, expelling the fragments instead by means of exciting contractions of the bladder by pressure above the symphysis or bimanual manipulation. His large experience of favorable results by which he supports this method allows him to speak with authority. He does not class perineal litholapaxy with the cutting operations, probably because of the minimal amount of cutting done. The author thinks his position with regard to the other cutting operations is too extreme, for reasons to be given later. The following remarks and table are taken from J. Forbes Keith's article:

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[1] *Lancet*, Sept. 30, 1893.

"Amongst lithotomes the first thing noticeable in the table is the enormous difference in the percentage of mortality amongst adults in comparison with that of children, whereas in the extension of the sphere of lithotrity this contrast gradually but completely disappears; for of the 2 deaths which occurred amongst the 408 cases operated upon since Jan. 1st of this year, one was that of a young man about twenty and the other of a female child about five years of age, so that lithotrity, according to the table, seems to tend toward an equilibrium of mortality amongst all ages and both sexes. The greater mortality amongst adults during the lithotomy period is assignable to three principal causes: 1. The insanitary state of the hospital, where erysipelas or gangrene, or both, attacked almost every adult who was operated upon, and amongst old men sloughing of the scrotum was common; but I have never seen a child or boy under fifteen years of age attacked by erysipelas after lithotomy. I have noticed an unhealthy discharge from the wound and a little swelling of the lower part of the scrotum, but only for a day or two, and this condition in the child never resisted treatment, as in the adult. The operation was performed in the adult just as well as in the child or boy, and they were both placed afterward under the same conditions. This immunity of children and boys under fifteen years of age must be attributed, therefore, to the fluids which bathe the vigorously developing tissues, forming a complete antidote to parasitic life. 2. Lithotrity at first absorbed the most favorable cases, leaving the less favorable ones to lithotomy, still laboring under insanitary conditions. 3. The system of operating on all who came to hospital under these conditions would no doubt contribute a certain percentage of mortality, for the weak and infirm would be, theoretically, less able to ward off contagion. With lithotrity, however, all this is changed. I have never seen erysipelas attack a case of lithotrity, either urethral or perineal. Its causes of mortality were suppression of urine and peritonitis arising from inferior instruments and my inexperience; for when I at last obtained my new set of lithotrity instruments I had a hundred cases without a death.

"From the time (1891) when perineal lithotrity was introduced, together with the other methods described above, mortality began to rapidly decrease, and even to almost disappear, as will be seen on referring to the table. At the end of last year a death occurred, Case No. 569, and in July of this year another took place, No. 970. Excluding from these 15 females, there remain 386 males of all ages. If 172 children and boys under fifteen years of age be deducted, there remain 214 adults who were operated upon in succession without a death; and amongst children and boys under fifteen years I have at present, including the perineal lithotrities, the number of 338, and these are still increasing. The weights of the largest stones which have been successfully removed by the above methods are—73 over one ounce, 17 over two ounces, 8 over three ounces, 3 over four ounces, and 1 over seven ounces. A glance at the table will show the success which attended Keegan's extension of lithotrity to children and boys under fifteen years of age. The number of operations which have been performed on this class of patients by eight different Indian surgeons is 663, with 18 deaths; the number performed by me, as will be seen from the table, is 503, with 4 deaths—giving a total of 1166 operations with 22 deaths, or 1.9 per cent.; and if my 106 perineal lithotrities be added, I have performed 609 operations with 4 deaths. There lie in lithotrity, therefore, an art and a potentiality which invite the enterprising surgeon to cultivate the one and to render practicable with proper instrumentation the possibilities of the other."

Table showing by statistical figures—(1) *the abandonment of the cutting operations;* (2) *the extension of the sphere of lithotrity;* (3) *the introduction of perineal lithotrity;* (4) *and the comparative rates of mortality of the several operations.*

	1889.			1890.			1891.			1892.			1893.			Grand total.		
	No.	Deaths.	Per centage.	No.	Deaths.	Per centage.	No.	Deaths.	Per centage.	No.	Deaths.	Per centage.	No.	Deaths.	Per centage.	No.	Deaths.	Per centage.
Lithotomy.																		
Men	91	14	15.3	54	6	11.0	15	5	33.0	3	1	33.0	. .	. .	. .	163	26	15.9
Children under fifteen.	103	2	1.9	101	1	0.9	. .	. .	. .	. .	. .	. .	. .	. .	. .	204	3	1.4
Women.																		
Total	194	16	8.2	155	7	4.6	15	5	33.0	3	1	33.0	. .	. .	. .	367	29	7.8
Lithotrity—Urethral.																		
Men	11	2	18.0	50	9	18.0	50	5	10.0	130	3	2.3	208	1	0.4	449	20	4.4
Women	5	. .	. .	11	. .	. .	6	. .	. .	12	. .	. .	15	1	7.1	49	1	2.0
Children under fifteen.	. .	. .	. .	. .	. .	. .	165	2	1.2	186	2	1.0	152	. .	. .	503	4	0.7
Total	16	2	18.0	61	9	14.8	221	7	3.2	328	5	1.5	375	2	0.5	1001	25	2.5
Lithotrity—Perineal.																		
Men	. .	. .	. .	. .	. .	. .	40	2	5.0	7	1	14.0	4	. .	. .	51	3	5.8
Children under fifteen.	. .	. .	. .	. .	. .	. .	39	. .	. .	38	. .	. .	29	. .	. .	106		
Total	. .	. .	. .	. .	. .	. .	70	2	2.5	45	1	2.2	33	. .	. .	157	3	1.9
Grand total	210	18	8.5	216	16	7.4	315	14	4.4	376	7	1.8	408	2	0.5	1525	57	3.7

The *relative proficiency* of the surgeon in the different operations should have some weight, not in determining what is the best operation for stone in general, but what is the best one for him to select in a given case. Litholapaxy is by far the most delicate and difficult of all the methods, and should not be undertaken by any one who is not thoroughly familiar with the manipulation of instruments in the urethra and bladder. The experience of most surgeons is that of a marked diminution in mortality as they acquire skill in the practice of any operation, but this is strikingly true of litholapaxy: there are some surgeons who, though admirable operators in other fields, never acquire the peculiar dexterity necessary for a successful lithotritist.

Permanency of Result.—There is undoubtedly more liability to recurrence after litholapaxy than after the cutting operations, and this is the chief point of criticism of the operation. It is true that in elderly men with enlarged prostates it is not easy to be sure of removing the last fragments of stone after crushing, and it is quite possible to overlook a small stone in a case of multiple calculi. These objections are overcome in a certain number of cases if perineal lithotrity be substituted for the usual urethral operation, but even so there will occur a number of cases in which the bladder cannot be examined digitally because of an elongated prostatic urethra due to prostatic hypertrophy; in such cases, therefore, the cutting operations have the advantage.

Injury to the Parts.—Litholapaxy's special superiority to all other methods lies in the fact that it involves no injury to the parts; next in order in this respect comes perineal lithotrity, as practised by Harrison and Forbes Keith: in this there is only the minimal injury involved in a perineal section; occasionally a fistula will result. Except for this, there is no injury done of the least consequence.

Lateral lithotomy injures the seminal ducts, which sometimes results in sterility—a serious drawback before middle life; it also involves often an extensive incision of the prostate or injures the gland by bruising it—sources of grave danger in elderly persons. Occasionally also serious hemorrhage results from the operation.

The suprapubic operation causes no permanent injury, but the disturbance of the anatomical relations of the prevesical space at the time of operation sometimes leads to the serious consequences already described when speaking of the technique of the operation.

IV., V., and VI. may be considered together. The coexistence of *bladder-tumor*, *tuberculosis*, or *severe cystitis* makes it important to lay the bladder open for inspection and operative procedures and subsequent drainage, and in such cases litholapaxy is not to be selected, but the suprapubic route, which gives the opportunity for carrying out those maneuvers. Again, if there is *ankylosis* of the hip-joint in such a position as to interfere with the use of the litholapaxy instruments, the latter operation would not be selected. *Stricture* of the urethra, unless impermeable or requiring a long operation in order to overcome it, is not a contraindication to the performance of litholapaxy; it can be dealt with at the same time that the stone is attacked by divulsing or rapidly dilating it immediately beforehand, without increasing the risks of the operation. If there is a *trabeculated bladder* or if the stone lies in a deep bas fond behind a *projecting prostate*, the outgrowths of which so fill the bladder or shelter the stone that it cannot be readily grasped by the lithotrite, the operation of litholapaxy may become impossible or too difficult to make it wise to attempt. *Encysted stone* necessitates a cutting operation. If under these conditions the suprapubic operation is decided upon, it should not be forgotten that the diverticulum in which the stone lies is very likely to have thin walls, and that, under the force of a large injection, the bladder might readily be ruptured at that point.

The choice of operation may be briefly summarized as follows: Litholapaxy is the operation of choice for the removal of vesical calculus in all except the following conditions: (*a*) When the stone is too hard to be crushed by the instruments capable of being used through the urethra; when this is the case median perineal lithotrity with the more powerful lithotrites that can be used in that operation after the manner described by Harrison and Forbes Keith in the case of adults, and lateral perineal lithotomy in patients under puberty, are to be preferred. (*b*) When the stone is too large to be grasped and successfully crushed or to be removed by the lateral perineal operation without injury. In that case the suprapubic operation, incising the perineum after Rydygier's method if necessary to accomplish the removal without bruising or lacerating, or else by fragmenting the stone if it can be seized by strong forceps and taking it away piecemeal. (*c*) In elderly patients with prostatic hypertrophy and small contracted bladders or those with deep bas fonds, making it difficult to seize the stone and its fragments, then select the median perineal lithotrity. (*d*) When the stone is encysted choose the suprapubic method. (*e*) When there is a tight or impassable urethral stricture, requiring a long operation to overcome, select the median perineal operation or the suprapubic. (*f*) When there is ankylosis of the hip-joint in such a position as to embarrass the movements of the litholapaxy instruments and to make lateral lithotomy impossible, the suprapubic operation is then to be chosen. (*g*) When foreign substances which cannot be crushed with the lithotrite form part of the stone, the cutting operations must be used. (*h*) In all cases in which litholapaxy would require prolonged anesthesia, and in which it is undesirable, the shorter cutting operations are to be preferred.

DISEASES OF THE URETER.

By CHRISTIAN FENGER, M. D., with the Collaboration of
S. C. STANTON, M. D.

ANATOMY.

The ureter is a cylindrical muscular canal, in the living subject probably contracted to some extent, with a rather uniform diameter of 3–4 mm. throughout its entire extent from the pelvis of the kidney to the bladder. It varies in length from 28–34 cm., according to Henle; 25–31 cm., according to Tanquary, cited by Van Hook; and Tanquary states that it never exceeds 38 cm. Luschka gives the length of the ureter as 27 cm., and Kelly states that it varies from 25–30 cm.

Its course is straight or slightly curved as it passes down from the kidney, and its direction is somewhat oblique, toward the median line. The curve described is sigmoid; above the small pelvis the slight convexity is toward the median line, while the pelvic portion is more strongly curved, almost the arc of a circle (Tanquary), with its convexity directed toward the lateral wall of the pelvis until it finally reaches the neck of the bladder, the wall of which it penetrates so obliquely that it runs for 1½–2 cm. between the muscular and mucous coats (Cabot). In the male it crosses the vas deferens on the posterior wall of the bladder; in woman it crosses the cervix and enters the bladder at a point midway between the meatus urinarius and the cervix.

Kelly gives a most valuable and minute description of the regional anatomy of the ureters. The ureter is divided into an abdominal and a pelvic portion by the bend over the common iliac artery about 3 cm. above the brim of the pelvis. The abdominal portion is 12–15 cm. long; the pelvic portion, 10–12 cm.

1. **Abdominal Portion.**—The abdominal portion may be divided into three parts—upper, lower, and middle. The upper is the most inaccessible portion for examination where it enters the pelvis of the kidney, as here it lies concealed by the ribs from 4–4½ cm. from the median line, and at about the same distance posterior to the anterior plane of the vertebral column. The middle part lies from 2½–3 cm. from the median line on the psoas muscle, and on a plane level with the anterior surface of the vertebral bodies. The ureter crosses the psoas obliquely till it reaches the common iliac artery at or just above its bifurcation, where it is about 3 cm. from the body of the sacrum. The course is thus obliquely downward and inward, with a slight inward convexity, and with always a marked convexity forward, due to its course over the psoas. The ureters lie in the loose cellular tissue back of the peritoneum, partly under the cæcum and the ascending colon on the right and the descending colon and sigmoid flexure on the left side. The abdominal portion of the ureter in its course over the psoas muscle is crossed by the ovarian or spermatic artery and vein, which descend into the pelvis along the outer border of the ureter. At the brim of the pelvis on the right side the ureter lies just behind the peritoneum, where it can be seen with

the ovarian or spermatic vessels. The peritoneum can be incised at this point and the ureter laid bare. On the left side the relations of the ureter to the sigmoid flexure and the rectum depend upon the length of the mesosigmoid and the variable position over the brim at which the rectum enters the pelvis. Thus in one case the ureter may lie beneath the sigmoid vessels and in another directly behind the intestine. (If we try to expose the left ureter from the right side of the sigmoid mesentery, it is covered by the sigmoid vessels. If we try to expose it from the left surface of the sigmoid mesentery, it is directly below the peritoneum.) After traversing the psoas it crosses the common iliac artery obliquely above or at its bifurcation, and enters the pelvis minor. This is the third or lower part of the abdominal portion.

2. **Pelvic Portion.**—The pelvic portion of the ureter (see Figs. 158, 159) lies first to the inner side of the internal iliac artery. In woman it is again crossed by the ovarian vein and artery, which pass over its anterior surface and leave it at an acute angle just above the inner border of the iliopsoas. In man the spermatic vessels do not cross the ureter a second time on the way to the inguinal canal, but diverge more and more from it. The ureter now descends to the floor of the pelvis in a forward direction. In woman it is crossed by the uterine artery, which passes over its anterior or upper surface at a right angle on its way inward from the internal iliac to the neck of the uterus. The ureter here passes through the base of the broad ligament along the upper lateral vaginal wall, and finally curves in over the anterior vaginal wall, following its uppermost converging folds, and terminates in the bladder, where the two ureteral orifices are connected by the inter-ureteral ligament.

Hallé and Tanquary have pointed out that in normal subjects the canal is narrowed in three places—namely, (*a*) at a point between 4 and 7 cm. from the pelvis of the kidney; (*b*) at the junction of the pelvic and vesical portions; and (*c*) at the place where it crosses the iliac artery, found in three out of five subjects. These localities correspond with the places where small stones from the kidney have been found to be arrested. The canal is not absolutely uniform in caliber throughout its entire course. When injected it is not of uniform caliber, but is always dilated, spindle-shaped in some places, so much so that the wider portions may be more than double the mean width of 6 mm. (Luschka).

The ureters are located in the retro-peritoneal tissue, surrounded by a layer of loose fat in well-nourished individuals (Luschka).

The wall of the ureter, according to Luschka, is 1 mm. thick and consists of three layers: (*a*) external, consisting of connective tissue rich in plastic fibers; (*b*) a double layer of organic muscular fibers—namely, an external layer of circular fibers and a thicker, internal layer of longitudinal fibers; (*c*) mucous membrane, easy to isolate from the muscular layer, rich in vessels, presenting longitudinal folds in the empty ureter, but perfectly smooth when the ureter is distended. Microscopical examination reveals neither papillæ nor glands. The epithelium is 0.05 mm. thick, and consists of nucleated cells of different shapes—namely, round and polygonal, cone-shaped and cylindrical, so arranged as to fit into each other.

Margarucci made researches regarding the circulation in the ureter from injection of the vessels in dogs. He found that the ureter has an artery on each side coming from the renal artery and running along the wall of the ureter almost to the bladder. From these two main arteries the branches perforate the wall of the ureter to supply the mucosa. If the injection is made through the hypogastric artery, the vessels of the bladder are filled, but the injection mass goes from the bladder up on the ureter for only a very short distance; consequently the ureter has its own vascular system from the renal artery, and has no important anastomoses with any of the arteries of the surrounding organs. This fact explains the possibility of isolating the ureter for a great distance without causing necrosis. Monari, as a result of injections on the cadaver, found that besides the main ureteral arteries coming from the renal artery, important arterial branches also come from the spermatic arteries, and that the arteries from these two sources supplement each other, so that if, as seldom takes place, the branches of the renal arteries are small, the branch from the spermatic artery is extremely well developed. Branches from the vesical arteries extend only to the extreme lower end of the ureter. It is thus evident that the ureter has its own circulation independent of the surrounding organs, which permits of extensive isolation without necrosis.

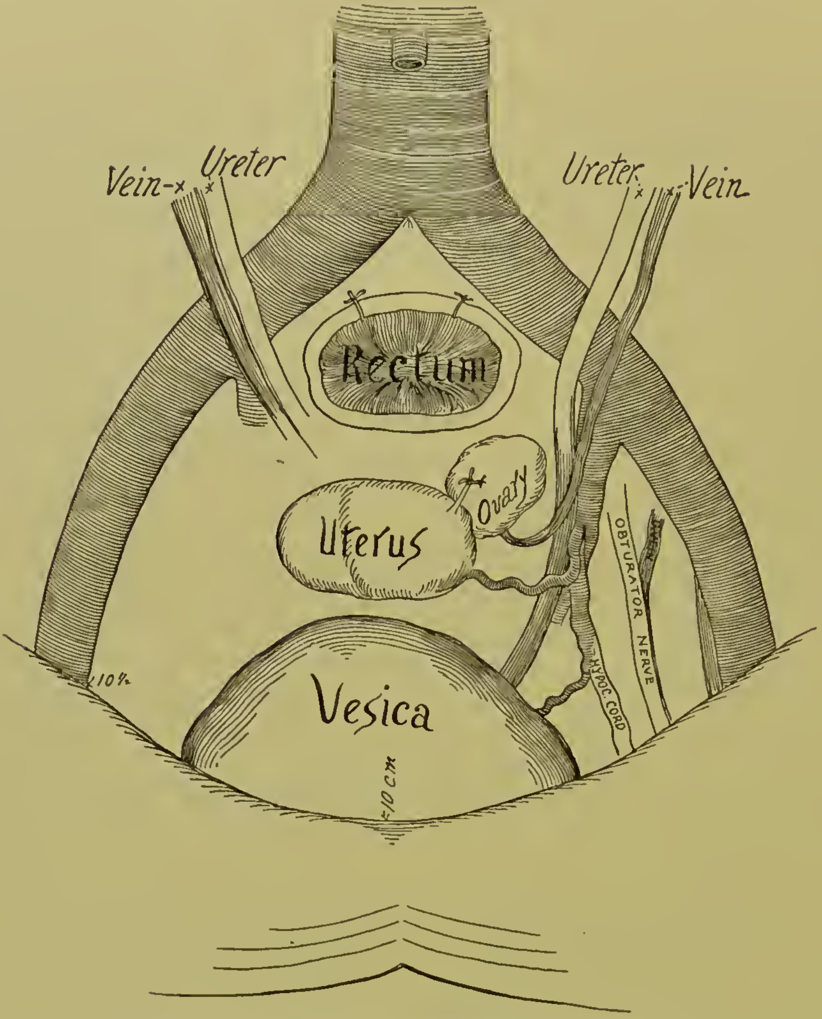

FIG. 158.—Pelvic portion of the ureter from below (Kelly).

Glantenay gives an admirable description of the relations of the ureters to the surrounding organs. He thus describes the pelvic portion of the ureter:

The *pelvic portion* consists of an upper parietal and fixed part and a lower visceral and more movable part.

The *parietal part* is covered with peritoneum where it crosses the iliac vessels, lying behind the ileum on the right side and the sigmoid flexure on the left, passes down over the pyramidalis and obturator internus muscles, from which it is separated by the pelvic fascia, and is here crossed by the obturator and umbilical arteries, branches from the hypogastric.

The *visceral part* leaves the lateral wall of the pelvis to pass toward the trigone of the bladder. In man it is crossed on the anterior surface by the vas deferens and deferent artery, and then lies close to the base of the seminal vesicle on its anterior surface, and enters the wall of the bladder above the prostate. It crosses the wall of the bladder obliquely, running in the wall for 2 cm.

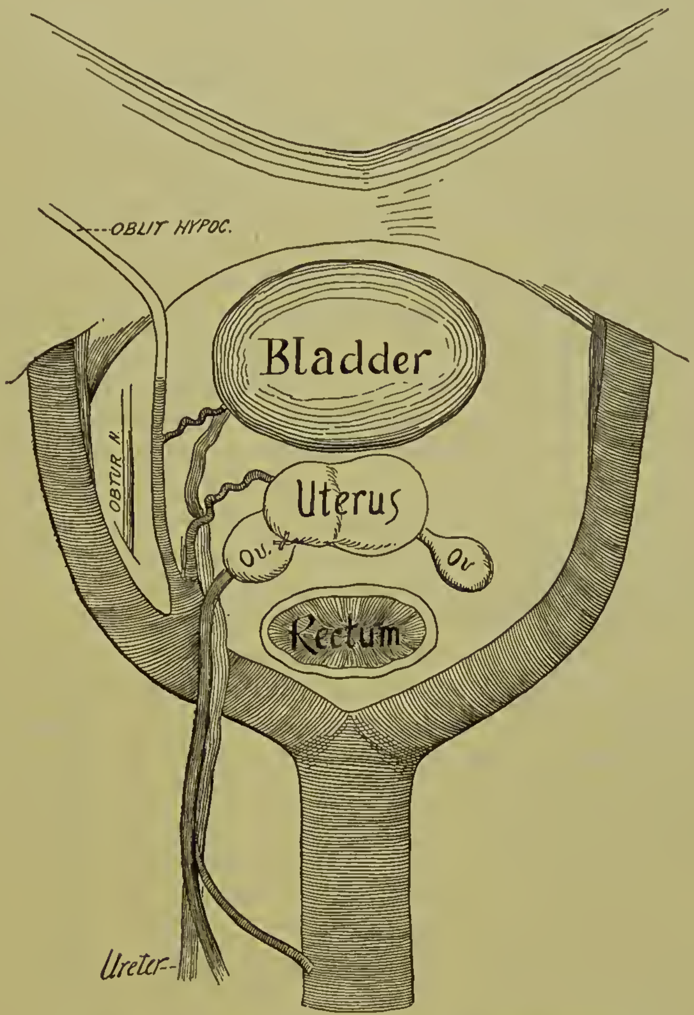

FIG. 159.—Pelvic portion of the ureter from above (Kelly).

The ureters open into the bladder near each upper corner of the vesical trigone, sometimes at the top of a little round prominence, sometimes on an oval prominence, sometimes in a depression. The distance between the two ureteral openings varies from 2–6 cm.

In passing down from the large to the small pelvis the left ureter lies between the vertebra and the psoas muscle, while on the right side, on account of the inferior vena cava, the ureter is situated a little more laterally.

Surgical Anatomy.—The relation of the ureter to the peritoneum is an important consideration in the surgical anatomy of the ureter. This was first carefully studied by Cabot, who pointed out that in extra-peritoneal operations, especially in fat subjects, it is extremely difficult to find and recognize the ureter in the deep wound, unless guided, for instance, by the presence of a stone. The ureter is adherent to the peritoneum, and always follows it when it is stripped up from the parts behind. This fact has been occasionally mentioned before by Crampton, Twynam, and others, but the condition was not studied until Cabot made microscopical sections of the ureter and peritoneum, and demonstrated that the ureter is bound to the under surface of the peritoneum by fibrous bands.

Cabot further pointed out that the relation of the ureter to that part of the peritoneum which is adherent to the spine is rather constant, the ureter being situated just external to the line of adhesion. Therefore, when the operator has stripped up the peritoneum and reached this point, he will find the ureter on the stripped-up peritoneum a little external to it. On the left side the distance from the line of adhesion to the ureter is from 1–2 cm., while on the right side the distance is somewhat greater, owing to the outward displacement of the ureter by the interposition of the vena cava inferior between it and the spine.

Monari studied on dogs the question of the extent to which the ureter could be isolated from the surrounding connective tissue without necrosis, and found that isolation for 12–13 cm. did no harm, provided it was carefully brought into contact again with the tissues from which it had been isolated, and at the same time when trans-peritoneal isolation was made covered with a flap of peritoneum. When these precautions were not taken there was danger of necrosis of the wall of the ureter, as was proven by the following experiment: He isolated the ureter, and kept it away from the surrounding tissues by packing a layer of gauze around it. If isolated for a distance of only 6 cm., necrosis and extravasation of urine followed.

As a guide in the palpation of the ureter on the living subject in examination for stone, dilatation or extravasation consequent upon rupture, the following landmarks are given by Tourneur, cited from Tuffier: The course of the abdominal portion of the ureter in the large pelvis corresponds to a vertical line erected upon a point at the junction of the internal and middle thirds of Poupart's ligament. Tourneur considers its direction vertical from the border of the kidney down to the small pelvis, over the brim of which it passes 4½ cm. from the median line. The exact location of this point is the intersection of a horizontal line drawn between the anterior superior iliac spines and a vertical line passing through the pubic spine. At this point, under favorable circumstances, a dilated or tender ureter may be felt by gentle, steady pressure backward upon the abdominal wall until the resistant brim of the pelvis is reached.

The vesical portion of the ureter can be palpated in man through the rectum. Guyon has called attention to the exquisite sensitiveness of this portion of the ureter upon rectal exploration in cases of stone, even when located high up. In woman vaginal examination permits the palpation of the ureter to an extent of 4–7 cm., as it runs in the broad ligament in close relation to the upper wall of the vagina (Cabot).

Access to the ureter is gained by two different routes, the trans-peritoneal and extra-peritoneal.

By means of a median or lateral abdominal incision the entire course of the ureter can be reached with comparative ease, but intra-peritoneal operations upon a ureter wherein the urine is not absolutely aseptic should not be undertaken if an extra-peritoneal operation is possible, on account of the danger of peritonitis. This is well illustrated by the trans-peritoneal uretero-lithotomy performed by Cullingworth, whose patient died from peritonitis.

On the other hand, abdominal examination for diagnostic purposes, to locate a stone or a para-ureteral urinary infiltration following rupture, has been of value when followed by extra-peritoneal operation, as evidenced in the cases of stone operated upon by Hall and Arbuthnot Lane, and in the cases of rupture reported by Page and Allingham.

Extra-peritoneal access to the ureter is technically much more difficult, because of the depth of the wound, but as by it the danger of peritonitis is avoided, it is on the whole preferable. The upper two-thirds of the ureter—that is, the abdominal portion and the portion which extends over the brim of the pelvis—can be reached by a continuation of the ordinary oblique incision for lumbar nephrotomy, from the twelfth rib at the outer border of the erector spinæ down along and 2 cm. anterior to the anterior superior spine of the ilium, and along Poupart's ligament to the outer border of the rectus.

The lumbar portion of the ureter is accessible through any of the varieties of the lumbar incision for access to the kidney. When the kidney is denuded from its adipose capsule, we search for the pelvis and the ureter below its posterior surface. Glantenay gives the advice to rotate the kidney a little around its pedicle by lifting the lower end of the kidney upward and outward, instead of pulling the whole organ into the wound. The ureter must be searched for by separating the loose adipose tissue which surrounds it, and, while it is easy to find a dilated or thickened ureter, it may be difficult to find a normal one.

Cabot thinks it would be possible in a very thin subject with lax abdominal walls or in children (Twynam) to gain access to the ureter down to within an inch or two of its entrance into the bladder by extra-peritoneal incision, but on account of the depth of the wound in this place operation would be difficult.

The lower pelvic portion of the ureter can be reached by the sacral operation—an incision lateral to the sacrum, as proposed by Delbet—or better by Kraske's operation, or the osteoplastic resection of the sacrum, as proposed by Cabot, who made investigations on the cadaver and found ample space for careful inspection and operation. However, Reynier in attempting to extirpate the lower pelvic portion of the ureter through a pararectal incision found the prostate and seminal vesicles easily, but was unable to find the ureter.

The pelvic portion of the ureter may be reached by the rectal, vaginal, perineal, sacral, iliac, and hypogastric routes. Of these only the sacral, iliac, and hypogastric really come into question. Glantenay believes that the sacral route may be preferable to the iliac in women, as it is easier to avoid the uterine artery and as the conditions for drainage are good.

In women the lower pelvic portion of the ureter can be reached through the vagina. Ureteral fistulæ opening into the cervix and vagina have been operated upon, and stones in this portion of the ureter have been removed by Emmet when situated low down close to the vesical orifice, and by Cabot when located higher up in the broad ligament, close to the cervix uteri. Kelly has extirpated the lower pelvic portion of the ureter through a wound in the vaginal vault.

The vesical portion of the ureter can be reached by suprapubic cystotomy.

MALFORMATIONS AND ANOMALIES.

It is well to remember the variations in the upper end of the ureter, as pointed out by Hyrtl. In the first variety there is no pelvis, but the ureter divides into two branches without dilatation at the point of division, each branch having a caliber a little larger than that of the ureter. In the second variety there is a pelvis—that is, a funnel-shaped dilatation at the point of division. The upper portion is the smaller and terminates in three short calyces; the lower and more voluminous portion terminates in four or five calyces. In the third variety there is only half a pelvis—that is, the lower branch divides and is funnel-shaped, forming a narrow pelvis which terminates in one, two, or three short calyces, while the upper is not dilated and extends to the upper portion of the kidney as a continuation of the ureter. The ureter not uncommonly divides far below the kidney, between the kidney and the bladder; sometimes there is no division at all, and two separate ureters enter the bladder.

There is one variation in the point of entrance of the ureters into the bladder which is of especial practical importance—namely, those cases, few in number, in which the ureter, instead of entering the bladder high up or low down, posterior to the sphincter of the urethra, opens into the latter at or near its external orifice, or even into the vagina (Secheyron). This anomaly causes a congenital partial incontinence of urine, for the relief of which operation has been performed with success.

The details of malformations and anomalies of the ureter have been studied by Carl Schwarz, who classifies abnormalities of the ureter as follows:

A. *Double Ureter with Normal Termination.*—Double ureter with normal termination is rather common (Weigert, 10 per cent.; Boström, 3 per cent.; Poirier, 4 per cent.). The ureters originate from separate pelves, and consequently double ureter means double pelvis. The double ureters either unite before they reach the bladder (incomplete duplication) or reach the bladder separately (complete duplication). The condition is unilateral or bilateral. By separate termination in the bladder the ureter from the upper part of the kidney will enter the bladder lower down than the ureter from the lower part. If one division of the double ureter is or becomes impermeable, atrophy or cystonephrosis of the corresponding territory of the kidney follows.

Visconti describes a case in which the right kidney was double the natural size and had a double ureter, and in which the left kidney was absent. He says that "when there is only one kidney, it is usually right-sided; the left kidney is absent."

B. *Abnormal Termination of the Ureter.*—1. Open termination inside of the male genito-urinary organs. The ureter may terminate—

(*a*) In the bladder, with narrow opening in the territory of the sphincter vesicæ;

(*b*) In the urethra, always in the prostatic portion, behind or at the side of the caput gallinaginis, usually with a small opening. A small opening signifies stenosis, and is followed by dilatation above. No ureter was ever seen to terminate in man outside of the sphincter urethræ;

(*c*) In the seminal vesicle, ejaculatory duct, or vas deferens.

As the abnormal termination is almost always so arranged that the passage of the urine is not free, we find the consequences of chronic retention—namely, dilatation of the ureter and pelvis and cystonephrosis. The cystonephrosis is partial in cases of double ureter, and is always located in the upper portion of the kidney, as the ureter from this portion is the one which has a termination outside of the bladder. When the ureter terminates in the seminal passages, there is usually a localized dilatation of the ureter on or in the wall of the bladder, where it forms a cystic tumor which protrudes into the bladder.

Of 23 cases of open termination inside of the male genito-urinary organs, 10 were of single and 13 of double ureter, which terminated 3 times in the bladder, 10 times in the urethra, and 10 times in the seminal passages.

2. Open termination in the female genito-urinary organs. The ureter may terminate—(*a*) in the urethra; (*b*) in the vagina; (*c*) in the vestibule; (*d*) in a persistent Gärtner's duct.

The ureter may enter the wall of the bladder in the normal place, but instead of opening in the bladder may pass along in the wall until it finally opens in the urethra, or it may run along over the fornix for some distance before it enters the urethra. In cases of this kind, where no incontinence is found, and where, consequently, some part of the muscular apparatus acts as a sphincter for the ureter, there are always stenosis and dilatation above, either localized, forming a sac close to the bladder, or diffused through the whole territory. This is also sometimes found when the ureter terminates in the vagina and vulva. In 23 collected cases belonging to this class the termination was 5 times in the urethra, 6 times in the vagina, 11 times in the vulva, and once in a persistent Gärtner's duct.

3. Blind termination of the ureter. This usually congenital anomaly is found in single as well as in double ureters, and we have here to consider both the place and the manner of the blind termination, as well as its consequences. The ureter usually terminates in the wall of the bladder, but sometimes in the muscularis and sometimes in the submucosa. On examination of the bladder we find, instead of the ureteral orifice, a flat or rounded cystic, thin-walled tumor which extends out over Lieutaud's triangle, and, when large enough, may compress the opening of the other ureter and fill up and close the entrance to the urethra. If this local termination of the abnormal ureter does not protrude into the bladder, it forms a cystic tumor on the outer wall of the bladder, and may form a prominence in the anterior vaginal wall.

As to the consequence of the anomaly in this class of cases, we find local or total uniform sacculated dilatation of the ureter, local or total cystonephrosis, sometimes of enormous size, or we find a small, atrophic, non-dilated kidney. In cases in which the dilated ureter protrudes into the bladder and compresses the urethra or the opposite ureter there will be stasis and dilatation of the other ureter and kidney, and excentric hypertrophy of the bladder. In 23 collected cases 15 were single and 8 double ureters, and in 5 cases death resulted from the consequences of the anomaly.

Orthmann narrates a case of "bifurcation" of the left ureter in a nullipara of twenty-seven years. The "second branch" terminated in a dilated cul-de-sac, forming a tumor of the size of a hen's egg on the anterior wall of the vagina, not communicating with the bladder. The tumor was extirpated.

4. Termination of the ureter in the rectum and cloaca (Schwarz). This anomaly was found only in non-viable fetuses and possesses no practical importance.

For explanation of the anomalies described above it is necessary to recall the embryological development. The ureter originates as a process branching off from the lower end of the Wolffian duct, growing from this point up into the kidney, and opening, together with the Wolffian duct, into the uro-genital sinus. By dilatation of the latter the two ducts separate, and the ureter comes to be located at a distance anterior to the Wolffian duct, which in man develops into the seminal passages, and in woman is obliterated or leaves a rudiment only, Gärtner's duct. If the ureter does not separate from the Wolffian duct, but remains a branch of the latter, the ureter will terminate in the seminal passages in man, and in woman in Gärtner's duct (one case on record). If the ureter separates from the Wolffian duct, but does not move up into its normal place on Lieutaud's triangle, we will have an abnormal termination low down in the prostatic portion of the urethra. If the ureter separates from the Wolffian duct without opening into a hollow organ, a blind termination results. If the ureter, instead of moving forward into the anterior portion of the cloaca, remains at its original location in the posterior portion, we find the termination of the ureter in the rectum. Double ureters originate either as a double branch from the Wolffian duct or as a single branch which later divides.

Symptoms and Diagnosis.—It is almost impossible to make a diagnosis of an anomalous termination of an ureter in the bladder, seminal vesicles, ejaculatory ducts, and male urethra unless perhaps by means of the cystoscope; and such a diagnosis has not yet been made. On the other hand, it is possible to recognize the abnormal termination of an ureter in the uro-genital system of women, and the ureters with blind terminations. The first of these conditions is characterized by a certain form of incontinence when the ureter terminates on the distal side of the sphincter of the bladder. It is an incontinence—that is, an involuntary, steady dribbling of urine, interrupted at certain intervals by a voluntary discharge of urine; in other words, the urine from the kidney with the abnormal ureteral termination is discharged continually (incontinence), while the urine from the kidney with the normal ureteral termination is discharged voluntarily at the usual intervals. A careful examination of the genital organs reveals a small opening in the vulva, vagina, or urethra from which the urine continually dribbles out. When a probe is passed into this minute opening it passes into a canal which does not communicate with the bladder. In three of the cases on record there was a saccular dilatation of the ureter, from the size of a pigeon's egg to that of a fist, a short distance above its termination. Such a sac might easily be mistaken for a second or double bladder.

The ureters with blind terminations may, if the lower end is dilated to a cyst or sac, be recognized by the protrusion of the sac into the bladder, or even into the female urethra. Digital examination or exploration may reveal their presence. A one-sided hydronephrosis, corresponding to the occluded ureter, will aid in the diagnosis. As yet, however, a correct diagnosis has not been made, but the knowledge of the anomalies above described may make a diagnosis possible in the future.

Treatment.—The abnormal termination of open ureters in the uro-genital apparatus in man will probably never be diagnosed, and consequently not be an object of treatment. The same may be said of open ureters terminating in the rectum, as this anomaly has been found only in non-viable fetuses. On the other hand, the abnormal termination of the ureter in the vulva, vagina, or urethra in woman has already often demanded surgical interference, with the object of curing the incontinence. The operation has for its object the direction of the abnormal ureter into the bladder as near as possible to the normal place, and the exclusion of the distal end of the ureter from the passage of urine.

The following methods have been used or proposed:

(1) Epicystotomy—implantation of the ureter in the posterior wall of the bladder and obliteration of the peripheral end. Tuffier performed epicystotomy and inserted a sound in the aberrant ureter, pushing its end so as to make it protrude into the bladder. From here he cut down upon it, making a longitudinal opening into the ureter. He then excised a piece of the peripheral stump, and cauterized the remainder with the Paquelin cautery. The upper end of the ureter was so well fixed in the bladder-wall that no further suturing was needed to secure it. Recovery.

Baum performed suprapubic cystotomy. In the bladder he found the two ureteral openings in their normal place. The third ureter was injected with water, and a dilatation the size of a pigeon's egg showed in the bladder below the opening for the right ureter. He made an incision intending to enucleate the third ureter, divide it transversely, and implant the central end into the bladder. This did not succeed, because the saccular dilatation was too large and thin-walled and the hemorrhage considerable. He then cut out a piece of the sac to make a large round opening into the third ureter, and sutured the margins of the opening with silk. On the distal side of the sac he ligated the third ureter and brought the knot out into the vagina. He then closed the wound in the bladder with a double row of silk sutures. Healing followed in four weeks. Five and a half months later a stone came out; the patient had a ventral hernia. The evacuation of urine remained normal.

(2) Excision of the distal end of the abnormal ureter—vaginal implantation of the proximal end into the bladder. The vaginal implantation, as probably the safest method, was chosen by Davenport in the following case: Woman, aged twenty-nine years; incontinence of urine from early childhood, due to malposition of the ureter. Incontinence increased by menstruation and pregnancy. One ureter was found in the vesico-vaginal septum, running forward, its orifice being close to the external orifice of the urethra. Operation for displacement of ureter and implantation of its orifice into the bladder. Recovery.

Baker isolated the peripheral end of the ureter from its termination in the vagina and implanted it into the bladder through an opening 1 inch from the neck of the bladder, suturing the vaginal mucous membrane over it. Recovery.

(3) Extra-peritoneal isolation of the abnormal ureter and the bladder through a convex subpubic incision, and resection of the lower border of the symphysis. Through this wound the ureter is isolated and its central end implanted into the bladder. Colzi reports one successful case.

(4) Uretero-cystostomy—a communication opening between the bladder and the dilated portion of the abnormal ureter. Wölfler effected this with apparent success by means of a special instrument analogous to or constructed on the plan of Dupuytren's enterotome.

Bois (d'Aurillac) reports the following case: Congenital incontinence of urine, although the bladder acted regularly. Fine canal in left wall of urethra, from which urine continually dribbled. A probe at this point passed into the left ureter. Division with tenotome of wall between ureter and bladder; opening kept open by bougies. Closure of the peripheral end of the ureter was postponed on account of pregnancy.

Criticism of the Methods.—Epicystotomy and implantation of the ureter in the posterior wall of the bladder, although successfully performed by Tuffier and Baumm, is a more grave operation than the vaginal implantation. The same may be said of the extra-peritoneal implantation with partial resection of the symphysis, as successfully performed by Colzi. To make a direct communication opening between the dilated ureter and the bladder, as done by Wölfler and Bois, is technically difficult. Thus the operation from the vagina is probably the safest method, and should be first attempted. If unsuccessful, one of the other methods might be resorted to.

Operation for blind termination of the ureters, when this condition can be diagnosed and the saccular dilatation protruding into the bladder causes retention of urine by occluding the posterior opening of the urethra, should be made on the plan of making a large communication opening between the bladder and the sacculated ureter by excising a large portion of the wall of the sac. This may be done in woman through the dilated urethra; in man by suprapubic cystotomy.

EXAMINATION.

Palpation.—1. Palpation through the vagina. Howard Kelly states that the ureter can be palpated through the anterior vaginal wall from its terminus in the bladder to the point where it passes beneath the broad ligament. It can be rolled in the loose connective tissue under the index finger or often bimanually between two fingers, or in advanced pregnancy on the head of the child, like a narrow tape or flattened cord without hardness. It must not be mistaken in this position for the obturator artery and nerve, or the upper border of the levator ani, or fibers of the obturator muscle, or the brim of the obturator foramen. A diseased ureter when nodular and thickened is apt to be mistaken for a cellulitis or adherent ovary.

When the ureter, whether diseased or not, is pressed upon or manipulated by palpation, it is characteristic that the patient complains of an intense desire to urinate. One patient in whom Kelly persisted in making the examination was forced to urinate on his hand.

2. Palpation by the rectum. An enlarged ureter can be palpated up to the brim of the pelvis in both man and woman through the rectum. (Stones have been felt here.) In woman the finger is brought up behind the broad ligament, and the ureter can be followed from this point up over the posterior pelvic wall. As an aid in the palpation of a normal ureter from the vagina and rectum Kelly has introduced a ureteral catheter or bougie and carried it up over the brim of the pelvis, whereby the catheter can be felt and alterations in the caliber of the ureter readily detected.

Kelly's landmark for the upper portion of the pelvic ureter is the internal iliac artery, which can readily be felt per rectum. In some individuals the artery can be palpated up to the common iliac, close along the inner side of which the ureter, if diseased, can be felt. If nothing is felt, it is safe to conclude that the ureter is not enlarged.

3. Palpation through the anterior abdominal wall. From the abdominal wall the ureter can be felt for 5 or 6 cm. from the brim of the pelvis up toward the kidney. A normal ureter can be thus palpated when it contains a catheter, and a diseased ureter when thickened.

4. Abdominal palpation of the ureters by surface landmarks is less satisfactory than palpation from below. Kelly's method consists in locating the promontory of the sacrum by pressure through the abdominal wall, and from this point locating the place where the ureter enters the pelvis—namely, 3–3½ cm. external to and a little below the promontory (see Figs. 160, 161). Here the fingers recognize the location of the common iliac artery, and the ureter which crosses it at this point can be felt when enlarged and when the

abdominal walls are thin. The patient complains of pain, and often of a desire to urinate, when the diseased ureter is touched.

5. Palpation of a thickened pelvic portion of a ureter after incising the vault of the vagina. Through this incision Kelly was able to follow the diseased ureter up to the posterior wall of the pelvis.

6. Palpation of the ureter through an abdominal incision. The ureter can be palpated directly by this means throughout the whole of the abdominal portion, and the upper 4 or 5 cm. of the pelvic portion for the detection of stones, tuberculosis, etc.

1. Various methods have been employed to determine disease of one kidney and presence or functional ability of the other:

Lawson Tait and Thornton: Exploratory laparotomy to determine existence, size, etc. of the other kidney in case of nephrectomy. This method is uncertain in fat persons (König).

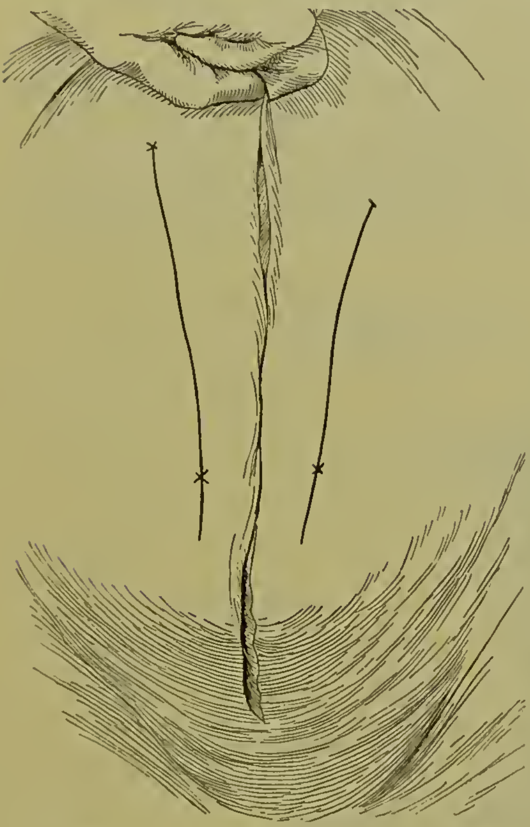

FIG. 160.—Course of ureters on skin of abdomen (Kelly).

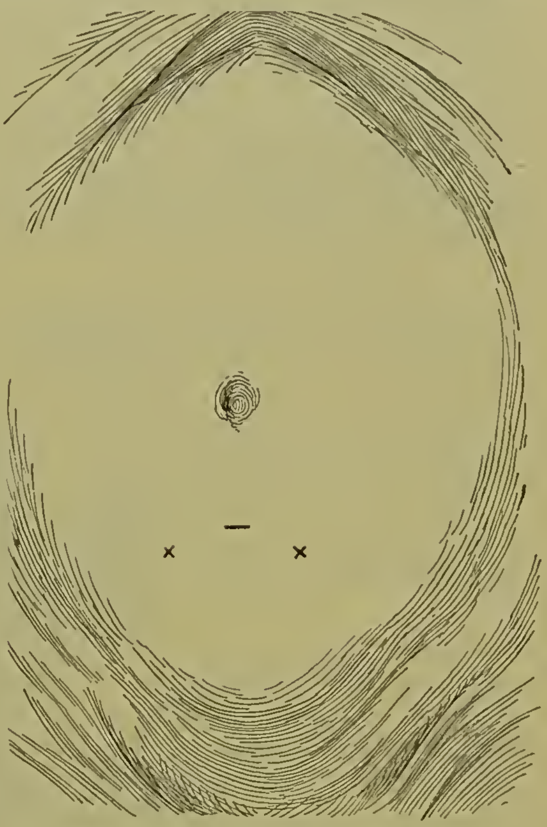

FIG. 161.—Landmarks on the skin for the transit of ureters from abdomen into pelvis (Kelly).

Fenger: Lumbar exploratory incision for palpation of the other kidney during nephrectomy for malignant disease.

Czerny: Exposure of the ureter by lumbar incision on the diseased side, temporary closure of the ureter, cleansing of the bladder, examination of bladder urine from the other kidney.

Gluck: The same as Czerny, but he gives the patient iodide of potassium. If iodine is found in the urine, the other kidney is present.

Iverson: Suprapubic cystotomy and catheterization of the ureters.

Hegar: In woman laying bare the ureter through an incision in the anterior vaginal fornix and temporary ligature.

Emmet: In woman incision into the bladder from the vagina, and catheterization of the ureters through this opening.

Harrison: Opening the bladder by a perineal section, through which he sees the ureteral opening and introduces a catheter. This method has been practised on cadavers only.

Silbermann: Quicksilver balloon in the bladder to compress the ureter.

Tuchmann: Ureteral forceps shaped like a lithotrite, introduced through the bladder.

Hegar and Sänger: In woman feel the ridge of the ureter through the vaginal fornix and pass a threaded needle around it for temporary ligature.

Ebermann: Compression of the ureter between forceps, one blade in the rectum and the other in the bladder.

Weir: Compression of the ureter from the rectum against the bones of the pelvis.

Sands: Compression of the ureter by the finger in the rectum.

2. To determine the presence of stone or obstruction.

Exploration of the ureter by sound or bougie from the pelvis of the kidney after nephrotomy, pelviotomy, or longitudinal ureterotomy.

Exploration of the ureter from the bladder by ureteral sound or bougie.

Catheterization of the Ureter.—1. *Direct Method.*—Catheterization of the ureter (see Fig. 162) has reached a state of practical usefulness by direct methods, but especially in woman, on account of the ease of access to the vesical opening of the ureter in the female. Pawlik was the first to put this procedure in extensive practice. He has employed it since 1881, using the knee-chest position without inspection of the bladder. Pawlik was followed by Newman, who employed an electric lamp through Simon's tubular speculum. The method has now been made practical chiefly through the arduous work of Howard Kelly in woman and Nitze, Casper, and others in man.

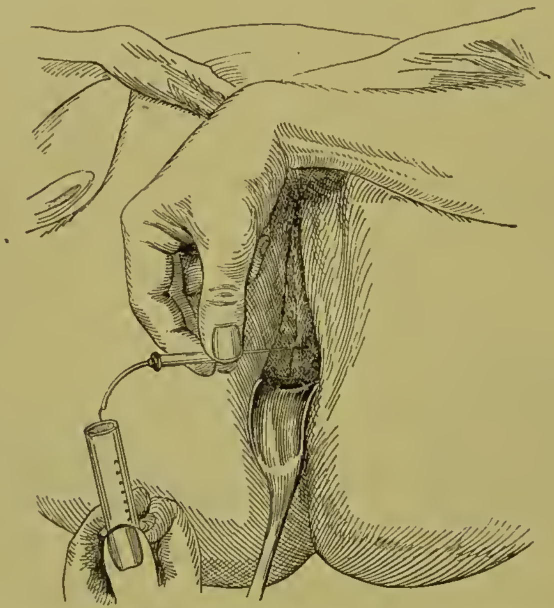

FIG. 162.—Catheterizing the ureters, one catheter (Kelly).

Strictures of the ureter and accumulations of urine above the strictures have been successfully treated in this way by Pawlik and Kelly. Kelly made a diagnosis of stricture low down in the left ureter by catheterization. The patient was catheterized about six times at intervals of ten to twelve days, each catheterization being followed by marked exacerbation of the pain for a few days. The consequence, however, of the repeated catheterizations was marked relief for several months. The symptoms finally returned, the ureter was opened from the vagina, and a small calculus removed from the ureteral orifice.

Pawlik mentions a case of pyonephrosis from Billroth's clinic in which he introduced into the ureter from the bladder a long elastic catheter with metal point, which passed through a stenosis of the ureter up into a cavity above. The patient had an abdominal fistula, the result of previous nephrotomy, and a probe passed through this fistula would touch the metal tip of the ureteral catheter. On attempting to withdraw the catheter the tip was caught in the stenosis and broken off, and Von Haeker removed it through the abdominal fistula.

Pawlik, cited by Albarran and Lluria, reported 2 cases of pyonephrosis in which this method was employed. In one case cure was effected after thirty soundings of the ureter; in the other the ureter was impermeable and nephrotomy had to be performed.

The treatment of tuberculosis of the bladder has been assisted by permanent catheterization of the ureters by Guyon, cited by Albarran and Lluria, who burned the tuberculous ulcers with the Paquelin cautery, packed with iodoform gauze, and was able to leave the ureteral catheters in place for nine days.

As regards leaving the catheter permanently in the ureter, Pawlik mentions a case of uretero-vaginal fistula in which a catheter was left in for seven days. Force was required to remove it, and it was found to be incrusted with salts.

Weil in a case of uretero-vaginal fistula caused by a pessary was enabled to stop the flow of urine by leaving a tube in the ureter for six days, when pain in the region of the kidney necessitated its removal.

A catheter left in the ureter for some time is apt to cause inflammation of the ureter, just as we find permanent urethral catheterization followed by inflammation of the urethra.

Poirier cautions against leaving a catheter in the ureter. He mentions a case of Segond's of exstrophy of the bladder wherein catheterization caused pyelonephritis, and a case of his own, in the service of Tillaux, in which, thirty-six hours after catheterization of the ureter, obstruction occurred, causing an attack of renal colic. He also cites the experience of Sinitzin, who was never able to allow a sound to remain for more than four hours, and concludes that the harmlessness of the procedure is not altogether beyond question.

Howard Kelly thus details his method of procedure in catheterization of the ureter in woman under direct inspection:

The following instruments are required for examination: A series of ureteral dilators, from 5–20 mm. in diameter; cylindrical specula with obturators of the same caliber (Fig. 164); a common head-mirror and lamp; a long,

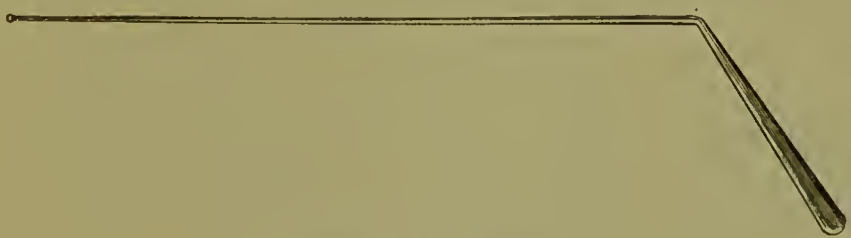

FIG. 163.—Ureteral searcher.

delicate mouse-tooth forceps; a suction apparatus for completely emptying the bladder; a ureteral searcher (Fig. 163); and a ureteral catheter without handle (Fig. 165).

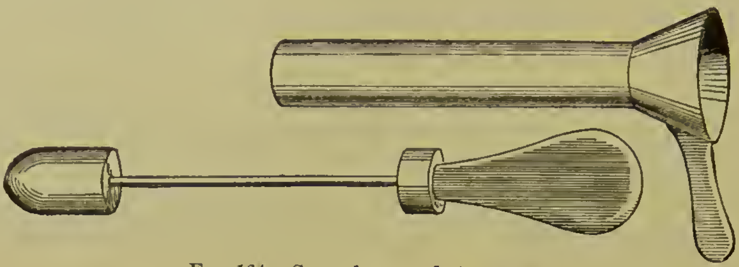

FIG. 164.—Speculum and obturator.

1. *Direct Method.*—The bladder is first emptied by the catheter. In order to determine the proper size of dilator to be used first, a calibrator can be pushed into the urethra and the corresponding dilator chosen. By introducing the dilators as they occur in the series, the average female urethra can easily be dilated up to 12 mm. in diameter, with only a slight external rupture. Kelly has never seen a tear more than 3 mm. in length and 1–1½ mm. in depth, and he has not had to incise the meatus, as Simon did, to avoid extensive rupture. Kelly's metal dilators are double-ended, of a flattened sigmoid shape, each end representing a single dilator in the series. The points are conical. On the flattened area in the middle of each dilator the diameter is marked in millimeters. This also affords a convenient grasp. As soon as a dilatation of 12–15 mm. is reached, a speculum of the same diameter is introduced and its obturator removed.

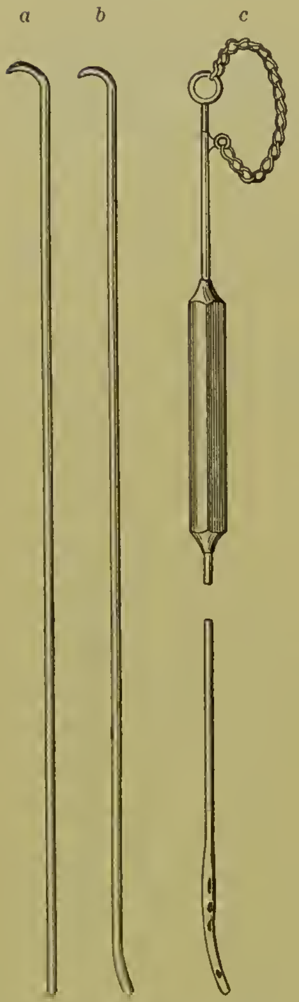

FIG. 165.—*a* and *b*, ureteral catheters without handles, for direct catheterization through speculum; *c*, ureteral catheter with handle sufficiently reduced in size to allow speculum to be withdrawn after catheter is engaged in ureteral orifice.

The hips of the patient are now elevated 20–40 cm. above the level of the table. The specula are 9½ cm. long, and each is provided with a conical mouth to assist in reflecting light into the bladder. The caliber is marked in millimeters on a little handle at the side of the speculum. Either artificial light or direct light from a window is sufficient for the head-mirror. When the obturator is withdrawn and the pelvis sufficiently elevated, the bladder becomes distended with air.

The urine remaining in the bladder is withdrawn by the suction apparatus, and what little urine still remains is removed by absorbent cotton on the forceps. The posterior wall of the air-distended bladder is 2–5 cm. distant from the anterior wall, and presents a whitish background with a network of vessels. The veins are darker in color than the arteries. The larger vessels coming to the surface from the deeper vessels divide stellately and anastomose. By moving the speculum by its handle the entire wall is successively inspected. The interureteric ligament can be seen as a slightly elevated transverse fold, sometimes of a different color. By turning the speculum thirty degrees to one side or the other the ureteral orifice can be found and the characteristic jets of urine, normal or pathological, can be seen. The ureteral orifices and their surroundings are not constant in their appearance. Sometimes the orifice appears as a little dimple or little pit, or, in inflammatory cases, as a round hole on a cushioned eminence; at other times as a V with the point directed outward. Again, it may be scarcely visible, appearing as a fine crack in the mucosa, and occasionally is so obscure as to be recognized only by the jet of urine or by a slight difference in the color of the mucosa. Rarely it has the form of a truncated cone with gently sloping sides. The bladder mucosa is usually a little deeper in color around the ureter. Upon direct inspection the ureteral orifice appears to lie nearer the urethra than one would anticipate.

As an aid in locating the ureteral orifice a point is marked on the speculum $5\frac{1}{2}$ cm. from its vesical end, and from this point two lines are drawn diverging at an angle of sixty degrees. The speculum is introduced up to the point of the V and turned to right or left until one side of the V is in line with the axis of the body. Then by elevating the speculum until it touches the floor of the bladder the ureteral orifice will usually be seen.

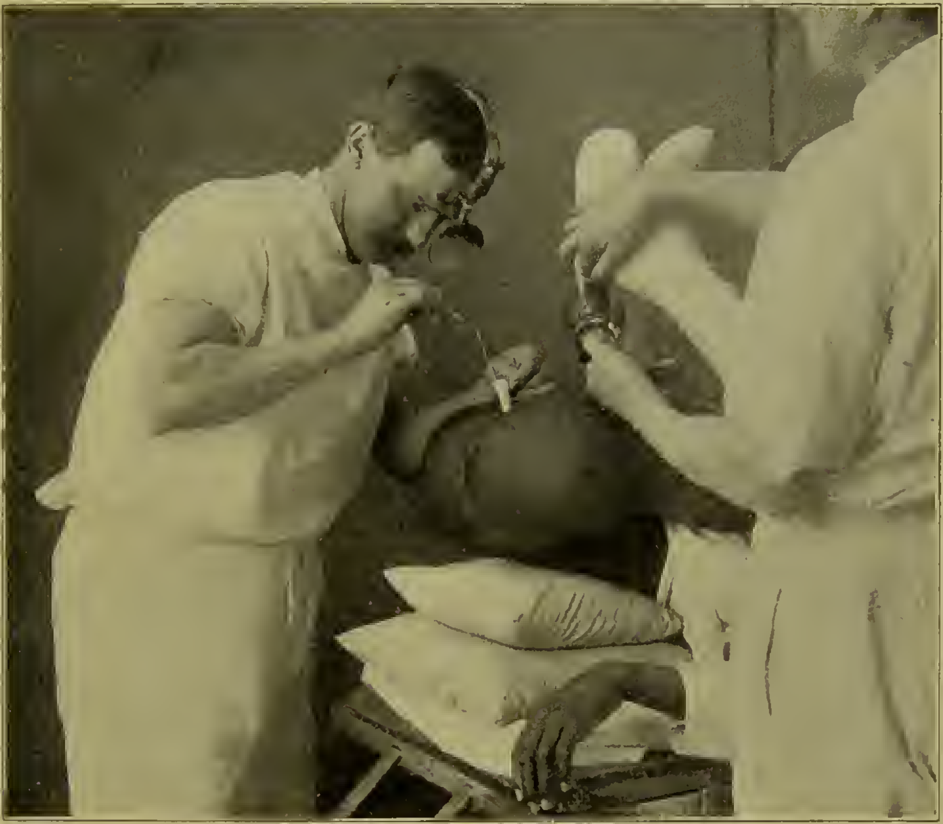

FIG. 166.—Left ureteral orifice exposed and searcher engaged (Kelly).

To determine the orifice of the ureter Kelly uses a searcher, a long, delicate probe with a bent handle, which is passed through the speculum into the suspected ureteral orifice, which when found permits the sound to pass up from 2–6 cm. The ureteral catheter is then passed. Kelly's ureteral catheters differ in shape from those of Pawlik in this respect, that they are straighter, and either have no handle or only a small one which will pass readily through a 10-mm. speculum. The catheter may be left in place some minutes or an hour or more. The urine which accumulates in the mean time in the bladder represents the discharge of the opposite kidney. Thus the urine of each kidney may be isolated by using only one catheter.

When the patient is placed in the genu-facial posture a higher degree of distention of the bladder takes place; the interureteric ligament is more sharply seen, but the ureters are not so plainly defined, as they are concealed by the outer extremities of the fold. The genu-facial posture is indispensable in some inflammatory cases when the bladder will not balloon out in the ordinary posture.

The ureters can also be catheterized without distention of the bladder with air—that is, without elevation of the pelvis. To find the ureters requires, however, more experience. The speculum is introduced from $5\frac{1}{2}$–6 cm., and its outer end elevated until the base of the bladder appears, when it is turned thirty degrees to the right or left to find the ureteral orifice. To prevent the residual urine from obscuring the field the speculum is gently pressed against the mucous membrane. It is then only necessary to take up the urine with pledgets of cotton as it flows from the ureter into the speculum.

An anesthetic is not necessary for catheterization of the ureter unless the urethra is to be dilated to No. 14 or 15.

In nervous women it is often better to make a thorough examination first under anesthesia; subsequently a satisfactory illumination of the bladder can be made and the ureters catheterized or local treatment applied through a No. 10 speculum without anesthesia. Anesthesia of the urethra can be effected by a pledget of cotton with 5 per cent. cocaine solution inserted seven minutes beforehand.

The instruments ordinarily required are four specula, Nos. 8, 10, 12, and 14; dilators Nos. 7–16; a long, delicate mouse-tooth forceps; a ureteral searcher; an aluminum applicator; and one ureteral catheter.

Catheterization of the ureters and introduction of bougies have proven of great value in abdominal hysterectomy for carcinoma of the cervix, and in hystero-myomectomy to avoid including the ureters in ligatures or cutting them, as the bougie will make it possible to feel and see the ureter during operation.

For use in the ureter Kelly has had constructed short (30 cm.) ureteral and long (50 cm.) renal catheters made of woven silk, and from 2–3 mm. in diameter. An oval eye is located 2 cm. from the conical end. Elastic bougies of the same size serve for diagnosis of blockades in the ureter, such as stone or stricture. A wire stylet stiffens the catheter during introduction and prevents it from coiling up in the bladder. The instruments are sterilized by boiling in pure water for two minutes, and are kept in sterile glass tubes.

By means of the renal catheter Kelly has been able to make the diagnosis of malignant tumor in the pelvis of a dilated kidney in a woman with a large tumor in the right side of the abdomen. He passed the renal catheter and evacuated 10 c.cm. of urine and some black specks, which upon microscopic examination were found to be pieces of stone. As the large elastic tumor remained, he was enabled to make a diagnosis of malignant tumor complicated with dilatation and some stone-formation.

2. *Indirect Method.*—Only a few years ago Perez stated that catheterization of the ureters was of no importance, as it could be done only by epicystotomy. In one instance catheterization of the ureter up to the healthy kidney in a case of left pyonephrosis in which granular casts were found in the urine, deterred Iversen from performing nephrectomy.

Keen in a case of hematuria and suspected tumor of the bladder performed epicystotomy, but found no tumor. As he was unable to determine from which of the ureteral openings the bloody urine was evacuated, he introduced a catheter through each ureter, and collected the urine separately, as a result of which he ascertained that the hemorrhage was from the left kidney. By means of the cystoscope, invented by Nitze and improved by him and by Oberländer, Otis, Brenner, and Caspar, with attachments for the introduction of ureteral catheters, catheterization of the ureters by this method first became possible, and is now becoming more and more practicable.

Nitze employs the cystoscope, aided by elastic bougies or catheters, which

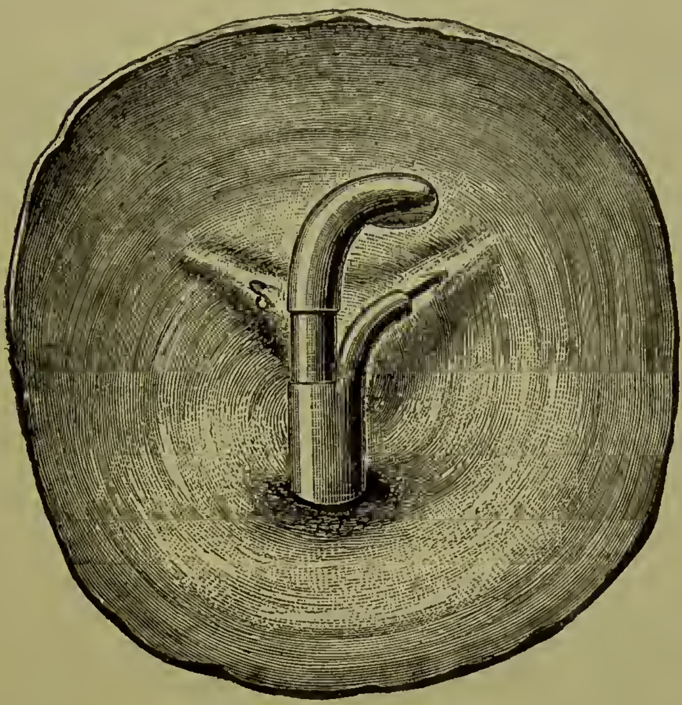

FIG. 167.—Nitze's instrument in use.

can be introduced and left in the ureter after the cystoscope has been removed. His method possesses the further advantage that all instruments can be easily sterilized and that both ureters can be catheterized at one sitting.

He states that the tube must be curved at the end and situated on the upper side of the cystoscope in a removable tube, the curve of which coincides with the bent end of the cystoscope. The ureteral catheter is inserted with the cystoscopic view as a guide. The curved tube permits the introduction of a ureteral catheter even in patients with hypertrophy of the prostate.

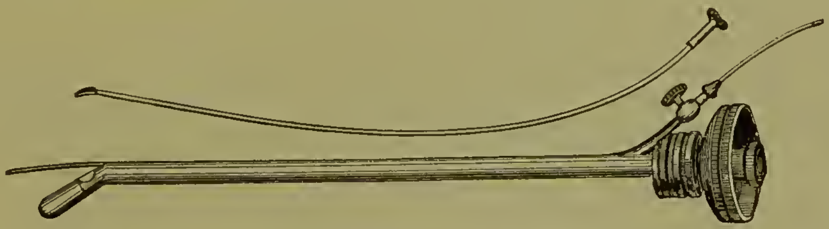

FIG. 168.—Brenner's ureter-cystoscope.

Brenner in 1888 modified the Nitze-Leiter cystoscope by incorporating a small tube with the tube of the cystoscope at its lower part (see Fig. 168).

Brown employs the Brenner instrument with the modification of a spring stylet with bent end, and succeeded at Johns Hopkins Hospital in catheterizing the ureter in man in the following two cases:

Case 1.—Right renal colic in a man of nineteen years, following trauma four years previous, followed by occasional hematuria. May 12, 1894, catheterization of the ureters. The anterior Leiter cystoscope was passed and replaced with the Brenner instrument. The ureteral orifice was found, the ureteral catheter inserted, and 3 or 4 c.cm. of urine collected from each ureter. The urine from the right ureter was cloudy and contained leucocytes; that from the left kidney was practically normal. He thereupon removed the right kidney, in one of the infundibula of which a calculus was found. The patient made a good recovery.

Case 2.—Left renal colic with hematuria, following trauma from lifting a heavy weight twenty-one years previous. The discharge of a calculus was followed by a cessation of symptoms. Four attacks of renal colic prior to 1886. Since that time constant dull pain in region of left kidney, greater behind than in front, and most intense at the brim of the pelvis. After dilatation of a urethral stricture catheterization of the ureters was done on November 21, 1894, under anesthesia, and 7 c.cm. of urine withdrawn. The urine from the left kidney contained granular and hyaline casts, red blood-corpuscles, epithelial cells, many pus-corpuscles, a small amount of albumin and calcium oxalate. The urine from the right kidney contained a trace of albumin, a few granular and hyaline casts, a few red blood-corpuscles, and occasional leukocytes, and flat and tailed epithelial cells. Noninterference with the calculous left kidney was advised.

Brown considers an enlarged prostate an insuperable bar to catheterization of the male ureter.

A. B. Gaither employs an injection of 2 c.cm. of 4 per cent. solution of cocaine into the deep urethra, and 4 c.cm. of the same into the bladder.

If the ureter is not easily found, it may be located by occasional jets of urine shooting across the window, or jets of blood in case of renal hematuria. The ureter may be inserted at such an angle as to render catheterization impossible. Raising or lowering the patient's legs or increasing or diminishing the fluid in the bladder may aid in finding the ureter. When the ureter is found the stylet is withdrawn and the catheter quickly slipped into the cannula. The tip of the catheter must have a sharp enough bend to engage in the mouth of the ureter, otherwise it slips over it along the bladder-wall. The bend in the catheter is brought about by means of the stylet, which is kept in the catheter for two days and imparts to the latter a corresponding temporary bend. (Nitze's cannula on the cystoscope has the necessary bend and obviates the necessity of the spring stylet.)

When the catheter is pushed into the ureter it can be seen running under the mucous membrane until it leaves the bladder-wall. It is essential for the finding of the ureters and introduction of the catheter that the bladder be capable of holding sufficient fluid (200 c.cm.) to bring the mouths of the ureters into view. Ordinarily it is possible after several attempts to catheterize the ureters, but the operator must necessarily be familiar with cystoscopic examination of the normal bladder, which requires considerable experience.

In chronic nephritis catheterization of the ureters may be of great value for the prognosis: namely, if disease is found to be in one kidney with the other normal or slightly involved, the prognosis is likely to be good, in spite of large quantities of albumin and casts, the patient living for years on the strength of the healthier kidney.

Max Nitze in his interesting article on cystoscopic diagnosis of surgical diseases of the kidney by means of catheterization of the ureters states that cystoscopy teaches us—

1. Whether the bladder is diseased or healthy;
2. If both kidneys or only one are acting;
3. It shows us the source of a hematuria from one or the other of the ureters. We see blood or bloody urine pass out with a jet from the ureteral opening on the diseased side, or sometimes a cylindrical clot hanging out of the opening;
4. Pyuria from one or the other of the ureters if the quantity of pus is considerable.

This author mentions 5 cases of so-called essential bleeding from apparently healthy kidneys, in 4 of which extirpation of the kidney saved the lives of the patients. In 3 cases of malignant tumor of the kidney the cystoscope determined from which kidney the hemorrhage proceeded, and, besides this, that the other kidney was present and excreted clear urine.

In pyuria the cystoscopic picture varies with the amount of pus. When little pus is present, it is seen to come out of the ureter as a darker shadow passing over the bottom of the bladder, or if the pus is abundant, a thick mass mixed with smaller and larger pieces of débris pours out of the ureteral opening. In one of his cases the pus was evacuated like a semi-solid mass, making the impression as if it was pressed out of the ureter like sausage from a sausage-machine.

Lohnstein has made a comparative investigation as to the value of the cystoscopic instruments of Leiter, Otis, Casper, and Nitze-Oberländer. He prefers Casper's instrument, because the disturbing reflexes from the uneven wall of the bladder are less troublesome, since this instrument works with reflected light. Furthermore, this instrument permits the use of a smaller tube on account of the absence of the cooling apparatus, and finally the glow lamp is more easily replaced in this instrument than in any of the others. The details of the cystoscopic view with Casper's instrument appear sharply and clearly defined, so that even a minute exudate can be distinctly seen.

In January 1895, Casper exhibited in the Berlin Medical Society his instrument (Fig. 169), with which he catheterized two men without anesthesia general or local. Below the canal for the optical apparatus was a groove for the ureteral catheter closed by a slide which could be removed after the introduction of the catheter, and the cystoscope then withdrawn, leaving the catheter *in situ*. This canal ends 6 mm. below the prism, and its end is so bent that the catheter comes out at an angle of 45° in the direction of the vesical end of the ureter. The lamp is in the long axis of the instrument, as proposed by Lohnstein. With this instrument he catheterized the ureters in 21 men and 1 woman. One of the men had hypertrophy of the prostate.

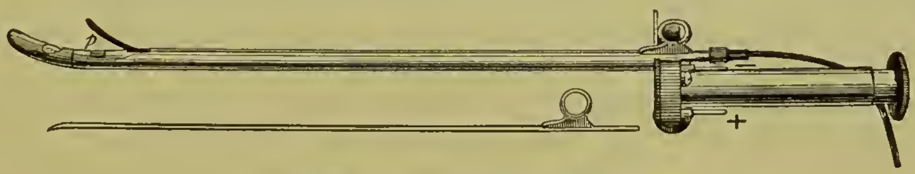

FIG. 169.—Casper's ureter-cystoscope.

It is necessary to have a clear view of the ureteral opening. After washing out, the bladder is filled with 150–200 c.cm. of clear fluid. By slight movements of the end of the instrument in various directions it is possible so to localize the ureteral openings that the end of the catheter must pass in. When this is done the cystoscope is so manipulated that the direction of the ureteral sound corresponds with that of the vesical portion of the ureter. After this maneuver the catheter is carefully pushed in. In all but 2 cases he was able to insert the catheter without difficulty and without especial inconvenience to the patient. As soon as the catheter is in the vesical end of the ureter, the urine commences to flow, usually at the rate of 8–10 grams in ten minutes. If with the catheter in this position fluid—for instance, boric-acid solution—is injected, colicky pains ensue, but if the catheter is pushed up into or nearly to the pelvis of the kidney, injection of small quantities of fluid causes no pain. The catheterization will not succeed in all cases: sometimes the openings are so small as to be scarcely visible; in other cases they are hidden by pathological swollen folds of vesical mucous membrane or protruding ridges, making it impossible to see them. Such cases are, however, in the minority, and ordinarily the method is applicable and useful.

F. Mainzer states that in Landau's clinic the cystoscopes of Casper and Brenner are used for the catheterization of the ureters in woman. He says it is easier to find the ureteral openings with Casper's instrument, but more difficult to introduce the catheter, while the opposite obtains with Brenner's instrument.

Poirier on injecting a ureter on the cadaver found that the injected mass passed out through the renal vein. At first he thought this was due to rupture from violence. Later he found, on injecting anesthetized dogs, that he could inject one, two, or three 10-c.cm. syringefuls of tepid water into the ureter. The kidney enlarged, and finally the water came out through the renal vein. He deduces that when a stone obliterates the ureter and the urine accumulates above, sufficient pressure may come to force the urine back into the renal vein. He advises that injection of medicaments into the ureter or renal pelvis shall be done without great force, to avoid forcing the liquid into the renal vein.

INJURIES AND WOUNDS OF THE URETER.

Subcutaneous Ruptures.—When these occur by violent direct injury, rupture of the ureter is apt to be accompanied by rupture of the other abdominal organs, the symptoms of which often dominate or mask those of the ureteral rupture. These injuries have been carefully studied by Herbert Page, who collected 10 cases from the literature, to which he added 1 of his own; 5 additional cases have been reported by Le Dentu, making 16 in all. In these cases the traumatism was caused either by a direct blow on the abdomen, such as the kick of a horse (Pye-Smith, Chaput), by a blow in the region of the kidney (Soller), by a blow from the handle of a wheelbarrow (Allingham), by being run over by a wagon (Page, Barker, Godlee, Bardenheuer), by traumatism from overstretching (Fenger), or by violent displacement of the kidney and pelvis whereby the ureter was ruptured in the upper portion (Le Dentu).

It is uncertain whether by these injuries the ureter is crushed against the transverse process of the first lumbar vertebra, as Tuffier thinks, or is so stretched from the kidney as to rupture in its upper portion, as in Fenger's case. Both methods are possible, The fact remains, however, that most of the ruptures are found above the small pelvis.

Early diagnosis is often difficult, if not impossible, because of the uncertainty of the symptoms. Slight transient hematuria, which might easily be overlooked, was noted in only 3 cases (Barker, Allingham, and Page). Copious hematuria, as reported in Hicks' case, indicates rupture of the kidney rather than of the ureter. Hematuria may be entirely absent, as in Godlee's case.

If no injuries to the other organs complicate the ureteral rupture, there are no grave symptoms in the beginning.

The next important symptom, swelling from the accumulation of urine around the place of rupture, is not seen until some time after the receipt of the injury—seven days (Allingham), two weeks (Chaput), two or three weeks (Godlee, Page, Barker, Hicks), thirty-nine days (Croft), seven weeks (Stanley), or several weeks (Cabot). The swelling is usually accompanied by pain, is localized, round, oblong, or sausage-shaped, following the course of the canal, and is palpable from the abdomen.

The **surgical treatment** has never yet been directed in an early stage to the ureter itself, but has consisted in puncture—single (Joel), once repeated (Hicks), or five times repeated (Stanley), all of which were successful—or incision and drainage, either through the abdominal cavity (Chaput, Page) or through the lumbar region (Allingham).

In most of the cases septic infection of the kidney took place through the resultant fistula, and secondary nephrectomy was necessary in order to save the patient's life (Godlee, Page, Barker, Chaput, and Bardenheuer). In other cases wherein the collection was not even opened and the patients survived, the kidney remaining, obliteration of the ureter (Havilland) or strictures ensued (Pye-Smith, Soller, Fenger).

As before mentioned, suture of the ruptured ureter has not yet been attempted, but, as Page points out, it might possibly be done, although it will probably be difficult to find the rupture; and this so much the more as an early diagnosis is rarely made. It is ordinarily not until some weeks later, when the swelling from urinary infiltration sets in, that operation is resorted to. Whether or not the ureter can be found in this cavity, which usually contains infected urine, and the rupture successfully dealt with, is as yet an open question.

Open wounds of the ureter, of which Tuffier found only 5 cases in the literature—3 incised or punctured wounds and 2 gunshot wounds—have not as yet been treated by direct ureteral surgery, as these cases date back to a time when such a procedure had not been thought of. If positive diagnosis can be made (and intermittent discharge of small quantities of urine at the time might make the diagnosis positive), and if the external wound is extra-peritoneal, there is no reason why the ureter should not be cut down upon and the wound treated by one of the methods now at our disposal.

Pozzi states that three injuries are possible:

1. Incomplete division;
2. Complete division without displacement or divided ends;
3. Loss of substance.

He suggests suture of the ends of the divided ureter.

Longitudinal wounds of the ureter will be considered in the discussion of the operation for stone. An extra-peritoneal longitudinal wound should be carefully united with extra-mucous sutures. In addition to the suture Van Hook makes a suggestion which appears valuable in cases where the incised ureter is covered with peritoneum—namely, to slide a fold of peritoneum from both sides over the sutured wound and unite the peritoneum over it. If no peritoneum can be used, an omental graft may be employed.

Transverse wounds of the ureter are much more difficult to treat satisfactorily, as there is a tendency to retraction and gaping of the wound, and as, if direct suturing is resorted to, there is always a tendency to stenosis even if the sutures do not tear out.

Reunion of a transversely divided ureter, first studied experimentally on dogs by Tuffier and others, was not successful until the method of invaginating the upper into the lower portion was devised by Poggi and Van Hook. It was first practised successfully in man by Kelly, who used Van Hook's method. Poggi divided both ureters in dogs, dilated the lower end with a forceps, invaginated the upper end into the lower, and united with sutures. When the animals were killed, fifteen days and three and a half months later, he found union without stenosis at the point of operation.

Van Hook has also succeeded in reuniting the completely divided ureter by a different method, which might be termed implantation of the upper into the lower end after closure of the end of the latter. In a very elaborate paper upon the surgery of the ureter he gives the reason why his method of lateral implantation is preferable to the simple invagination of Poggi. He believes that the ureter can sustain resection involving a considerable amount of tissue, since ureters measuring 25 cm. while *in situ* will easily measure 30–35 cm. when removed, and he further remarks that elongation by traction on the divided ends is probably practicable to a very considerable extent.

Van Hook proposes in incomplete transverse wounds to transform the transverse into a rhomboid-shaped longitudinal wound by opening longitudinally upward and downward from the transverse wound and cutting off the four corners, thus creating a condition similar to that produced when a stricture of the ureter is opened longitudinally. The rhomboid wound may then be united transversely by folding the ureter upon itself in the manner proposed by Fenger in the operation for stricture.

This operation will probably be safe in extra-peritoneal wounds. If, however, the wound opens into the peritoneal cavity, it is not certain that covering with a fold of peritoneum will be sufficient: it might be safer to divide the ureter completely, and then resort to Van Hook's method of lateral implantation.

Early attempts to unite complete transverse wounds of the ureter, as a rule, failed in experiments upon animals and in operations on the human subject. In Tuffier's experiments on dogs death from peritonitis usually followed, and when union took place there was so much cicatricial constriction as to cause stenosis.

In the first case in which direct union was attempted in the human subject the result was also unsatisfactory. This case was reported by Schopf.

Schopf's Case.—During laparotomy for the extirpation of an intra-ligamentous ovarian cyst he divided the ureter near the brim of the pelvis. Having secured the divided ends by artery forceps, he united the ureter by silk sutures, which did not pass through the mucosa and probably invaginated the borders of the transverse wound. The patient made an uneventful recovery, but died seven weeks later from tuberculosis. The autopsy showed that the right ureter at the place where it crosses the psoas muscle was imbedded in cicatricial tissue, and that a cicatrix existed in the entire circumference of union.

Uretero-ureterostomy.—Van Hook's method of invagination (Figs. 170, 171)—or uretero-ureterostomy, as Kelly calls it—is an important step forward in this direction, as it has proved on animals and men sufficient to prevent leakage and also stenosis. He describes his method as follows:

"1. Ligate the lower portion of the tube from 3–6 mm. from the free end. Silk and catgut may be used. Make, with fine sharp-pointed scissors, a longitudinal incision twice as long as the diameter of the ureter in the wall of the lower end, $\frac{1}{2}$ cm. below the ligature.

"2. Make an incision with the scissors in the upper portion of the ureter, beginning at the open end of the duct and carrying it upward $\frac{1}{2}$ cm. This incision ensures the patency of the tube.

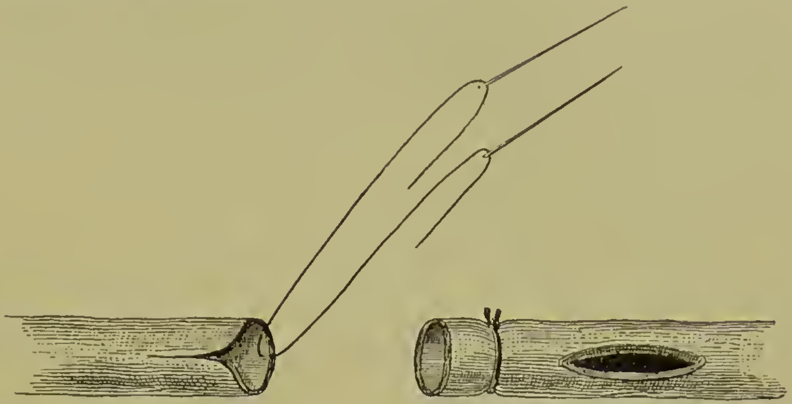

Fig. 170.—Uretero-ureterostomy (Van Hook's method). The needles have been introduced into the wall of the renal portion of the ureter. The end of the vesical portion of the tube has been ligated and a slit made in its wall.

"3. Pass two very small cambric sewing needles, armed with one thread of sterilized catgut, through the wall of the upper end of the ureter 3 mm. from the extremity, from within outward, the needles being from 2–4 mm. apart and equidistant from the end of the duct. It will be seen that the loop of catgut between the needles firmly grasps the upper end of the ureter.

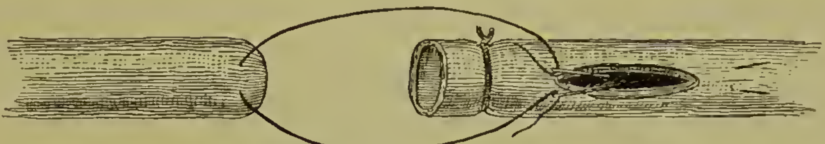

Fig. 171.—The needles carrying the traction suture attached to the renal portion of the ureter have been passed into the slit in the wall of the vesical portion, carried down a short distance, and pushed out through the wall.

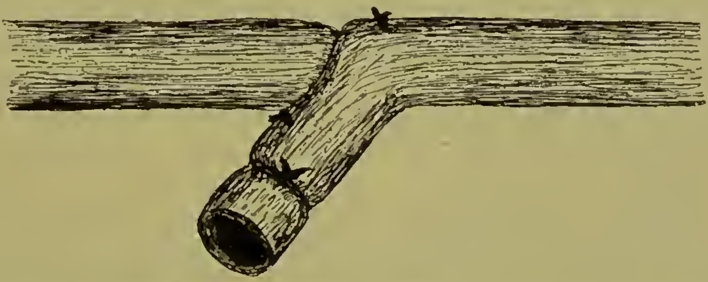

Fig. 172.—By means of the traction suture the renal portion of the ureter has been implanted into the vesical portion. The ends of the traction suture have been tied together.

"4. These needles are now carried through the slit in the side of the lower end of the ureter into and down the tube for 1 cm., where they are pushed through the wall of the duct side by side.

"5. It will now be seen that the traction upon this catgut loop passing through the wall of the ureter will draw the upper fragment of the duct into the lower portion. This being done, the ends of the loop are tied together securely, and, as the catgut will be absorbed in a few days, calculi do not form to obstruct the passage of the urine.

"6. The ureter is now enveloped carefully with peritoneum, as already described in other operations, provided an intra-peritoneal operation has been done."

Bloodgood has repeated Van Hook's experiments with equally satisfactory results. In addition to Van Hook's procedure, Bloodgood applied two sutures through the external coats only as an additional security against leakage. His drawing of the united ureter shows not only no narrowing of the caliber at the point of union, but even a little diverticulum of the canal.

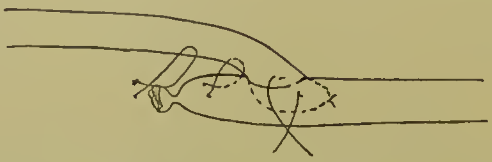

FIG. 173.—Ureter anastomosed; traction sutures tied; and two fixation sutures in place ready to be tied (Bloodgood).

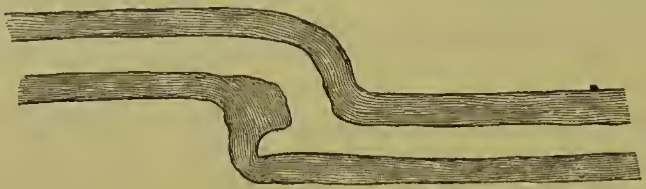

FIG. 174.—Longitudinal section of ureter, showing new lumen and diverticulum (Bloodgood).

A most important and interesting proof of the value of this method has been furnished by Kelly in the first operation of this kind on the human subject. This important case was the following:

Kelly's Case.—Mulatto, twenty-five years of age, who had a large uterine myoma, filling both true and false pelvis and extending above the umbilicus. Hysterectomy was performed May 1, 1892. The ureter was ligated and cut, supposing it to be an engorged vein. Ureter was four times its normal size by reason of pressure from the tumor (hydro-ureter). On removal of upper ligature 20 c.cm. of clear urine escaped. Van Hook's plan tried of tying lower end of divided ureter, making slit in ureter below ligature and implanting upper into lower end by means of silk traction sutures. Edges also sutured to intussuscepted portion by ten fine silk rectangular sutures passed through outer coat only. Gauze laid over anatomosed end and brought out at lower angle of abdominal wound to ensure drainage. No urinary odor about the dressings. Passed water second day. Discharged cured in six weeks.

B. McE. Emmet in removing a tumor from the pelvis divided the left dilated ureter at the level of the fifth lumbar vertebra. Although the upper end of the dilated ureter was wider than the lower, he succeeded in making a union by Van Hook's method, and the patient recovered. He used fine silk for the sutures.

Oblique End-to-end Uretero-ureteral Anastomosis.—J. Wesley Bovee reports the case of a woman of thirty-six who had received a blow on the right flank from a stone thrown by a boy, followed by an exudate in the pelvis to the right of the uterus. Abdominal section, performed April 30, 1896, showed a right tubo-ovarian abscess, during the extirpation of which the right ureter was included in the ligature of the ovarian vessels and cut off. The diagnosis was made by passing a sound through the lower end of the ureter down into the bladder, and after enucleation of the sac of the abscess an end-to-end anastomosis of the ureter was made in the following manner:

The ends of the ureter were cut obliquely, the lumen dilated for an inch, and the ends sutured together with fine silk. With a small round, straight needle a rectangular suture was inserted and tied, but not very tightly. Two interrupted sutures followed, and this alternation of rectangular and interrupted sutures was continued until the entire circumference of the ureter had been sutured. Over these sutures were inserted four or five interrupted sutures. None of them penetrated the mucous membrane of the ureter. The sutured ureter was covered by sewing the peritoneum over it. The abdominal wound was closed without drainage. For the first two days the urine was withdrawn by the catheter every six hours. The wound healed in two weeks, and the patient left the hospital four weeks after the operation. Four months later the urine was normal. A month later a sound was passed freely into the right ureter, and no constriction could be found.

The author concludes that uretero-ureteral anastomosis should be done preferably by lateral implantation (Van Hook's method) or by oblique end-to-end anastomosis (the author's method), although the transverse end-to-end method may be safely employed.

STONES IN THE URETER.

It is a common occurrence that small renal stones pass down through the ureter, under the symptoms of renal colic, into the bladder to be evacuated with the urine. But it is comparatively rare that a stone is retained in the ureter permanently. This takes place when the stone is too small to be retained in the renal pelvis and too large to pass entirely through the normal ureter, or when a small stone which would pass through a normal ureter is retained in a ureter with strictures, valves or bends.

Stones in the ureter are usually small, round or oval, single or multiple. As an exception may be mentioned a stone in the St. George's Hospital Museum, 14 cm. long, which almost filled one of the ureters (Harrison).

Stones in the ureter are most commonly arrested in the upper portion, and with about equal frequency in the middle and vesical portions.

Uric-acid and oxalate-of-lime stones may be found in a non-infected urinary tract, while phosphatic calculi are found after infection has taken place. The ureter at the seat of the stone shows symptoms of chronic inflammation, the wall is thickened or the ureter is dilated, and the stone may cause pressure atrophy and perforation. In the vesical portion of the ureter the dilated canal may protrude into the bladder, forming the so-called encysted stone of the bladder. Above the seat of the stone the ureter is often dilated, so that the stone can be pushed up into the pelvis of the kidney. In other cases, where there is only a local dilatation at the seat of the stone, this is not possible. The ureter below the stone is often smaller than normal, either from contraction due to chronic ureteritis or from disuse, when little or no urine passes down.

When once permanently located in the ureter the stone may increase in size. So long as no infection has occurred the disturbance is merely mechanical, causing dilatation above, and at the most only a local aseptic inflammation at the seat of the stone.

Infection usually takes place, however, sooner or later, and on the whole it is more common to find pyonephrosis than simple aseptic dilatation.

The **symptoms** are pain, renal colic, intermittent cystonephrosis, or calculous anuria. In many cases the symptoms are not typical, and the beginning is often insidious, as the symptoms of renal colic may disappear when some urine passes down by the side of the arrested stone. The location of the arrested stone can usually not be diagnosed from the symptoms, which are substantially the same whether a stone is arrested in the pelvis of the kidney or at any place in the ureter down to its vesical end. Dilatation of the ureter above the stone can very rarely be felt, and the stone itself has been felt in only one case near the middle portion of the ureter, while when located in the vesical portion it may be palpated through the vagina or rectum. When the end of the stone protrudes into the bladder it may be felt by a steel sound.

Location of pain in the ureter is of value only when fixed pain or tenderness remains in the same place after the intermittent attacks of renal colic have passed away. Guyon has called attention to the fact that excessive sensitiveness at the vesical orifice of the ureter upon rectal exploration may indicate stone in the ureter. Pain increased by walking or flexing the body is found both in stones in the pelvis and in the ureter. Abdominal palpation in the line of the ureter, as indicated in the anatomy, should be done by gentle, steady pressure until the fingers feel the resistance of the posterior abdominal wall; but this is of value only in thin subjects with lax abdominal walls. Rectal and vaginal palpation should be aided by pressure with the other hand above the symphysis pubis.

As to the course of stones in the ureter, it is well to remember that some cases present no symptoms whatever. Sometimes spontaneous expulsion takes place after several months; in other cases infection and calculous pyelonephritis come on after an interval free from symptoms following the original renal colic. Calculous anuria was found in about 50 per cent. of the cases operated upon (Tuffier), and oftentimes the bilateral obstruction comes on insidiously without any symptoms in the previous history to indicate the lesion of the opposite kidney.

The **diagnosis** may be easy if the stone is located in the vesical end of the ureter, but it is usually difficult or impossible for stones in the middle or upper portion. The pain is not characteristic, as the same fixed pain is found in nephrolithiasis, pyelonephritis, and neurosis. Pain may be absent entirely, and in some cases no symptoms of stone in the ureter have been present until dilatation of the pelvis—cystonephrosis—develops. Stones in the middle or upper portion of the ureter cannot be diagnosed from stones in the pelvis or calyces of the kidney.

As an aid in the diagnosis of renal calculi catheterization of the ureter has been done by Kelly in the two following cases:

1. Pyelitis; colon bacillus infection. Several black specks in the pelvis of the kidney were withdrawn by suction with the renal catheter. The specks were found to be uric-acid gravel. By nephrolithotomy a renal calculus was removed.

2. Small black pieces of stone were caught in the eye of a renal catheter in a case of pyonephrosis; the end of the catheter showed scratch-marks from the stone, and a diagnosis of renal calculus with pyonephrosis was made.

This procedure may also prove of value in the diagnosis of stones in the ureter.

The **treatment** consists in removal of the stones. This may be accomplished by different methods according to their location.

(*a*) *Removal through the Bladder.*—Stones have been removed by dilatation of the female urethra by Emmet, Berg, Richmond, Czerny, and Sänger; by suprapubic cystotomy in 2 cases (Tuffier). Ureteral stones often protrude into the bladder and can be recognized by the sound. The mucous membrane covering them may have to be divided, but the stones are usually extracted without difficulty. The wound in the vesical end of the ureter is generally left open, but is sometimes sutured, as in the case reported by Berg. Stones in this location, so far as operative procedure is concerned, should be classed among stones in the bladder.

When stones are located a little higher up, but are not accessible from the bladder, they may be reached by—

(*b*) *Ureterotomy through the Rectum.*—Ceci removed successfully a stone from the ureter by incision through the rectum.

(*c*) *Ureterotomy through the Vagina.*—Removal of stone by means of vaginal ureterotomy has been performed by Emmet and Cabot.

Emmet's Case.—A click having been elicited by the sound, ureteral stone was suspected. On backward pressure with a larger sound a stone could be felt through the vagina and rectum. Stone cut down upon through vaginal wall by scissors. Opening enlarged forward toward the neck of the bladder, this being the only safe direction to avoid entering the peritoneal cavity. Opening closed with interrupted sutures. Good recovery.

Cabot's Case.—Woman aged thirty-nine. Attacks of renal colic for sixteen years, often followed by passage of stones. Left pyonephrosis felt as a distinct tumor. Vaginal examination revealed small hard mass in left broad ligament close to cervix uteri. Sound in bladder could not be brought within half an inch of mass. Ureterotomy and removal of stone through vagina. Evacuation of ten to twelve ounces of pus. Tumor in region of kidney disappeared. Uretero-vaginal fistula remained for four months with small amount of pus. The author concludes that the kidney was destroyed so far as secreting tissue was concerned.

(*d*) *Extra-peritoneal ureterotomy* has been performed by Twynam, Cabot, Ralfe and Godlee, Kirkham, Morison, and Fenger.

Twynam's Case.—Boy, eight years. Left renal pain, hematuria. Laparotomy for diagnosis revealed stone in right ureter just below brim of pelvis. Laparotomy wound closed. Three weeks later extra-peritoneal incision in right iliac region; ureterotomy, removal of stone, ureterorrhaphy, drainage; recovery. Long ends of sutures brought out of wound.

Cabot's Case.—Man, forty years. Seven or eight sharp attacks of pain, referable to left side of abdomen, above middle of Poupart's ligament, during three months before operation. Sensitive spot on back midway between crest of ilium and twelfth rib. Diagnosis: stone in ureter. Lumbar incision; ureterotomy; removal of calculus two inches below kidney; wound in ureter not sutured; recovery.

Ralfe and Godlee's Case.—Woman, twenty-six years. Renal colic persistent on left side. Lumbar nephrotomy. No stone in kidney. Exploration revealed stone in left ureter two inches below kidney. Longitudinal ureterotomy; removal of stone, Subsequent passage of gravel and small stone *per urethram;* recovery.

Kirkham's Case.—Man, fifty-eight years. Right renal colic, followed by pain on left side and anuria. Diagnosis: destruction of right kidney by previous attack; left kidney now affected. Exploratory left lumbar incision. Palpation of kidney negative. Stone in ureter half an inch above the point of crossing of external iliac artery. Ureterotomy; removal of stone; no sutures; drainage; recovery.

R. Morison's Cases.—1. In a case of anuria due to calculus in the right ureter Morison removed two stones from the right ureter close to the bladder by extra-peritoneal ureterotomy, and closed the wound in the ureter with fine catgut. The patient died on the table. Autopsy showed dilated right ureter, sacculated right kidney with interstitial nephritis; left ureter occluded by stones. Left sacculated kidney contained no kidney tissue.

2. Man, thirty-one years. Occasional left renal colic, no hematuria. Lumbar incision; stone in ureter three inches below the kidney removed by ureterotomy. Wound in ureter left open; recovery.

Fenger's Case.—Man, thirty-five years. Increasing attacks of renal colic for two years. No hematuria; no tumor. Diagnosis: nephrolithiasis. Lumbar nephrolithotomy. No stone in kidney. Palpation showed two stones in the ureter one and a half inches below kidney. Longitudinal ureterotomy; no sutures; recovery.

(*c*) *Intra-peritoneal ureterotomy* has been performed by Cullingworth and Arbuthnot Lane.

Cullingworth's Case.—Woman, thirty years. Right renal colic; large pyonephrosis. Vaginal examination showed hard masses to the right and left of uterus. Diagnosis: right pyonephrosis and independent ovarian disease. Laparotomy. Right ureter dilated. Stone immediately above bladder. Ureterotomy; removal of stone; escape of pus. Ureterorrhaphy, with interrupted silk sutures. Glass drain in abdomen. Death from peritonitis in eighty hours. Autopsy revealed right and left pyonephrosis. Sutures in ureter held.

Arbuthnot Lane's Case.—Woman, twenty-three years. Left renal colic for twenty years; hematuria; pyuria. Laparotomy. Pelvis of left kidney dilated. No stone. Ureteral opening could not be found. Eight months later laparotomy. Stone in pelvic portion of ureter forced up to crest of ilium. Abdominal ureterotomy; removal of stone. Ureterorrhaphy, with continuous silk suture; no leakage; recovery.

Diagnosis as to the location of the stone was made before operation only in the cases in which the stone was afterward removed through the rectum or vagina (Ceci, Emmet, Cabot). When the stones are located higher up it is, as a rule, impossible to make a positive diagnosis. In the small pelvis diagnosis may possibly be made by vaginal examination, but in Cullingworth's case he mistook the stones for diseased ovaries, and positive diagnosis was not made until the abdomen had been opened.

If the stone is located still higher up, diagnosis of location is wellnigh impossible. Cabot made the diagnosis of stone in the ureter, but could not locate it until a lumbar incision had been made.

The location of the stone has not been determined until exploratory incision, either extra- or intra-peritoneal, has been performed. When the stone has been found in this way its removal has been accomplished either by pushing it up into the pelvis and extracting it through an opening in the pelvis or kidney, or by longitudinal ureterotomy.

It is often impossible to push the stone up into the pelvis because of the local dilatation of the ureter, the nest, as Le Dentu calls it, but some operators, such as Israel, Von Bergmann in two cases, Hall and Tuffier, have succeeded in accomplishing this. Fenger tried, unsuccessfully, to push a stone into the pelvis by a needle passed through the wall of the ureter. He does not consider this procedure important if the ureter can be reached by an extra-peritoneal incision.

The difficulty in dislodging the stone is well illustrated in the case reported by Hall, who succeeded only after manipulations with one hand in the abdomen.

Hall's Case.—Woman, thirty-six years: had had recurrent attacks of renal colic for four years. No hematuria. Pain in region of left kidney, which could be palpated between the hands. Examination caused no hematuria. No stone could be felt. Dr. Hall was unwilling to make a lumbar incision on uncertain diagnosis, and advised exploratory laparotomy. Examination in narcosis revealed a small tumor in region of left kidney—the dilated ureter above the stone. Abdominal section: stone could now be felt about three inches below the kidney. Lumbar incision for removal of stone. Stone difficult to dislodge, finally accomplished by hand in abdomen. Incision on convex surface of kidney; invagination of sac consisting of dilated ureter and pelvis. Extraction of stone; recovery.

The dislodgement and removal of the stone were easy in the case reported by Tuffier.

Tuffier's Case.—Renal colic for nine years, finally attended with constant pain. Right kidney enlarged. Nephrolithotomy. Examination revealed no stone. Examination of ureter showed hard ovoid body, 3 cm. long, at place where ureter crossed the promontory. Stone movable, and was pushed up into pelvis of kidney. Incision of convex surface of kidney. Extraction of stone. Suture of kidney and lumbar wound. No drainage. Healing by first intention.

Longitudinal ureterotomy has thus been done in 7 cases through an extra-peritoneal incision, 6 of which were successful, and 1 patient died; and in 2 cases through the abdomen, 1 case was successful, and 1 patient died from peritonitis.

The treatment of the ureteral wound is different in the extra- and intra-peritoneal operations. In the intra-peritoneal operation immediate absolute closure of the ureter is of vital necessity: as the urine above a stone is almost always infectious, the question of accurate suturing is one of great importance. In the extra-peritoneal operation, where the infected urine can be drained out effectually until the wound closes, the question of suturing is of little importance.

In his trans-peritoneal operation Arbuthnot Lane used a continuous silk suture with perfect success. In Cullingworth's intra-peritoneal operation he employed interrupted silk sutures, and post-mortem examination revealed no leakage from the wound in the ureter.

In an extra-peritoneal operation Twynam applied interrupted silk sutures, the long ends of which were brought out through the wound. As might be expected, the sutures did not hold.

In some of the extra-peritoneal operations no sutures were used, but drainage was employed, and the wound closed in Kirkham's case in forty days; in Fenger's case in a month; in Fenger's case of exploratory longitudinal ureterotomy in fifty days; and in Cabot's case the wound also closed without disturbance.

Whenever practicable the stone should be removed through a lumbar incision rather than through the abdomen. Stones located low down in the small pelvis, which cannot be pushed up within reach of an extra-peritoneal incision, like that for ligation of the iliac artery, might be reached by a sacral operation, although no case of this kind is as yet on record.

Laparotomy for the purpose of diagnosing the location of the stone has been of value in several instances. In Arbuthnot Lane's case the stone was thus located after exploratory lumbar incision had failed. In this case, however, it might have been possible by opening the kidney or ureter and exploring above to locate the stone through a lumbar incision.

In Hall's case the stone was located through a median abdominal incision and removed through a lumbar nephrotomy. As in this case it had already been determined which ureter was the seat of the stone, the laparotomy might have been omitted.

In Twynam's case, however, exploratory laparotomy was absolutely necessary, since the symptoms pointed to stone in the left ureter, which was healthy, while the stone was found in the right ureter, and was removed three weeks later by an extra-peritoneal ureterotomy.

The operative results for stone in the ureter are, on the whole, favorable. In 17 cases collected by Tuffier only 3 patients died, and in these cases the other kidney was diseased. In ordinary cases, in which a certain amount of healthy secreting kidney tissue remains, removal of stones from the ureter presents no more dangers than removal of stones from the kidney or its pelvis.

The question of gaining access to different portions of the ureter in order to overcome obstruction has been solved, so far as the removal of stones is concerned, by a number of operations already on record, as follows: The vesical end of the ureter has been reached from the bladder by Emmet, Richmond, and others; from the vagina, by Emmet and Cabot. The pelvic portion of the ureter has been reached by extra-peritoneal lumbar incision, and the stones removed either by pushing them up into the pelvis and pyelotomy in 4 cases (Tuffier), or by longitudinal incision of the ureter in 4 cases (Tuffier), and by Fenger in 1 case.

From the middle portion of the ureter stones have been removed in 4 cases (Tuffier) by longitudinal ureterotomy by the prolonged lumbar incision. There is no difficulty in gaining access to the upper two-thirds or three-fourths of the ureter by the oblique lumbar incision. It is different with the lower third or fourth of the ureter, which is located deep down in the pelvis, and is even held by Le Dentu to be inaccessible. But Cabot has justly pointed out that this portion of the ureter is also accessible without opening into the peritoneum by means of the sacral operation of Kraske, with removal of part of the sacrum or temporary resection of the latter.

VALVE-FORMATION, BENDS, AND STRICTURES.

Valve-formation and oblique insertion of the ureter was first noticed in the case reported by Glass and cited by Rayer. A girl was born with right hydronephrosis, and died at the age of twenty-three. At the autopsy three gallons of liquid were found in the sac. On the interior surface of the sac the orifice of the ureter was seen as large as a goosequill. The ureter passed obliquely for 30 cm. between the membranes of the sac, and was patent the entire distance to the bladder. On account of the non-obstruction of the ureter Rayer considers this the most remarkable case on record.

Rayer observed a case of double hydronephrosis in which the ureters were also patent, which he attributed to congenital malformation. The patient was a boy of seventeen, who had been sickly all his life, and had had pain for seven years in the region of the left kidney. A tumor was found and the diagnosis made of left hydronephrosis. He died from septic infection of the sacs. At the autopsy the left ureter was found patent, the upper portion situated in the wall of the sac, with an opening almost similar to a valve in a vein. Water passed easily from below upward, but not down from the sac into the ureter. There was a small hydronephrosis in the right kidney. The right ureter was dilated to the size of a lead-pencil from the bladder up to the sac. At the upper end it was retracted, and when water was injected from below it entered the sac through an opening the size of the lachrymal punctum.

Virchow in discussing hydronephrosis remarks: "The cases are extraordinary in which hydronephrosis exists with the ureter patent. I have examined such cases several times, and have found in each case a valvular obstruction caused by folding of the wall, due to oblique origin of the ureter from the renal pelvis."

Simon gives a full and comprehensive description of this condition. The ureter does not enter the pelvis of the kidney at its lowest point with a funnel-shaped opening, but enters it at the side at an acute angle, and often runs for a variable distance in the wall of the pelvis. In 2 similar cases observed the ureter ran, not in the wall proper, but between the wall and the peritoneal covering for 7–10 cm. In contradistinction to the previous authors, who thought that valve-formation was the cause of the hydronephrosis, and therefore congenital, Simon believes that the hydronephrosis in its beginning causes the valve-formation, and consequently that valve-formation is not a congenital affection. He has examined a specimen in which a stone was found in the ureter 5 cm. from the pelvic orifice in a case of hydronephrosis the size of a child's head, and with valve-formation in the upper end of the ureter. He believes that temporary obstruction from any cause may produce sufficient asymmetrical dilatation of the pelvis to give rise to oblique insertion and valve-formation, which when it once exists, even if the primary cause of obstruction disappear, may remain as a permanent obstruction of greater or less degree to the passage of urine. He considers valve-formation in hydronephrosis very common, as he found it in 11 out of 18 reported cases.

The mechanical aspect of valve-formation in the causation of intermittent hydronephrosis was studied by Krakauer, who made experiments designed to explain the fact that spontaneous evacuation of urine is sometimes seen in hydronephrosis due to this cause. Acting upon the proposal of Simon, Krakauer produced an imitation of the hydronephrosis due to valve-formation in the following manner: He caused to be made a rubber balloon having a capacity of 150 c.cm., with a tube which ran for several centimeters in the wall before opening at an acute angle into the side of the balloon. When the balloon was filled to distention, he observed that the first 50 c.cm. were evacuated rapidly, the second 50 c.cm. less rapidly, and the remainder still less readily. From this experiment Krakauer concluded that a higher pressure in the balloon, equivalent to an overfilling of the distended pelvis, is capable of overcoming a greater hindrance or impediment in the tube of exit—the ureter—than is a lower pressure. Applying this fact to the obliquely inserted ureter in the dilated renal pelvis, he concludes that partial filling of the dilated pelvis will close the valve entrance and permit no evacuation through the ureter; further accumulation of urine and over-distention of the dilated pelvis will overcome the obstacle and the urine will be evacuated through the ureter. This fact explains intermittent cystonephrosis.

Tuffier has studied the mechanism and treatment of intermittent hydronephrosis as caused by movable kidney by a series of experiments, the first of which takes into consideration the mode of formation of the hydronephrosis. In the first experiment he made an artificial exstrophy of the bladder on a dog. A few days later he examined the function of the ureters, and found the same number of contractions, jets, and the same quality and quantity of urine on both sides. He then mobilized one kidney, and found, first, that the intervals between the jets grew larger and the quantity of urine one-third to one-fourth less, but the proportion of urea was unchanged. From the sixth to the eighth day the pelvis and ureter became distended above the bend, especially the pelvis.

As neither the pelvis nor the kidney has a muscular layer capable of compensatory contraction, the hydronephrosis once established would continue. The first symptoms, then, are increased pressure of the urine in the pelvis and renal congestion. The distention later on leads to bending of the ureter at the border between the fixed and movable portion—namely, at the pelvis. It is usually in a line with the renal vessels that the bend is found after four weeks.

Secretion and absorption may take place above the bend. The organ may continue to secrete for a long time. Patients have been found to live for several years with one kidney only, and this kidney hydronephrotic (Wright, Küster). The kidney tissue may remain relatively healthy.

The same was observed in some of the experiments. A dog with intermittent hydronephrosis of forty-five days' standing lived after ligation of the other ureter, and microscopic examination of the hydronephrotic kidney tissue showed only interstitial edema and dilated collecting tubes, but a normal condition of the kidney tissue.

Convincing proof is also found by uranalysis. In the experiments the urine from the bladder—that is, from the other kidney—and the urine from the dilated kidney contained the same amount of urea. This was also found in some observations on man in the cases of Rogers, Rochet, and Weir, and in one case by Tuffier in the service of Tillaux.

The kidney showed various changes in shape: In 3 operations the kidney was increased in volume and horseshoe-shaped; in another it formed almost a complete circle. In another variety the kidney was elongated, flattened, and had the shape of the tongue of a dog (one of Tuffier's observations). Tuffier believes this change in shape is characteristic of the initial stage of hydronephrosis, and that if he had taken this into consideration he would have observed more than 9 hydronephroses in his 45 nephropexies.

The physical phenomena in the beginning of hydronephrosis are as follows: The kidney is a secretory organ, but has the power to absorb liquids and salts. In a state of retention the kidney absorbs part of the liquid contained in the calyces, pelvis, and collecting tubes. It is easy to prove this endosmotic action. There is only little absorption in the ureter, but rapid absorption in the calyces and parenchyma in the normal condition; when there is retention and pressure, however, absorption becomes rapid. Tuffier injected 2 ctg. of strychnine into the pelvis of the kidney of a dog. It produced no symptoms until the ureter was ligated. In spite of this absorption of liquid under pressure, in spite of this distention, the kidney tissue goes on secreting for a long time in the intermittent—that is, open—hydronephrosis.

On the other hand, when the hydronephrosis becomes closed and of long standing, the secretion of urea first diminishes, then stops, and the secreting kidney tissue gradually disappears.

Intermittent hydronephrosis has a double mechanism:

(*a*) The bend is movable. In the beginning it is easily straightened out when the kidney is brought into position. Even when the pelvis is much distended it can be straightened out by replacing the movable kidney. This was proven in a case where the bend straightened out when the patient lay down. At the operation Tuffier found a large, fluctuating, horseshoe-shaped kidney, the pelvis much dilated, and the ureter normal. This condition was entirely cured by nephropexy.

(*b*) The kidney is immovable, and the bend is forced when the tension reaches a certain point. Tuffier found in an operation the following condition: the kidney was voluminous, but not very tense; the bend was visible, and the ureter empty below. Pressure on the kidney forced the liquid down through the bend.

Consequently, intermittence may be due to two mechanisms: 1, straightening of the bend, and 2, a certain degree of pressure.

Tuffier considers that a causal relation between intermittent or permanent cystonephrosis and mobility of the kidney is shown by the following facts:

1. Cystonephrosis is more frequent in women: 21 women to 5 men; Tuffier's 12 operations were all on women.

2. The seat of the hydronephrosis is on the right side in 21 out of 23 cases. This is in accord with the opinion of Landau, defended by Terrier and Baudoin, but Tuffier considers himself the first who has given anatomical proof of this by experiments and clinical observations. In his experiments on dogs he produced a bend in the ureter as follows: Through a lumbar opening he rendered the kidney movable and fixed the ureter in some cases, fixed the kidney in an abnormal position in others, and left the movable kidney and ureter without fixation in others. He had 4 negative results and 5 hydronephroses. The latter presented the following conditions: 2 or 3 cm. below the hilus there was a sharp bend of the ureter. The pelvis and kidney above were thin-walled and distended, the more so the longer the condition had existed—from seven to fifty-five days. These hydronephroses were open—that is, a slight compression on the kidney caused the liquid to force its way through the bend. In these cases the kidney continued its function, as was proven by an experiment in which the opposite ureter was ligated, and the animal remained alive in spite of the intermittent cystonephrosis.

The simple mobilization of a healthy kidney is sufficient to cause a hydronephrosis, and this condition is due to bending of the ureter. When the kidney is lifted up the bend is straightened out, and there remains only the difference in diameter above and below to show the place of the former obstruction. The bend can consequently be straightened out with the utmost facility. The bend is formed by displacement of the upper movable portion of the ureter upon the lower immovable portion. Tuffier gives some very instructive plates showing the changes in kidneys and ureters of the animals experimented upon. Besides these experimental results, he has seen this bend of the ureter in two operations for hydronephrosis. In 1892 in a case of nephrectomy for cystonephrosis he dissected out the ureter and found an S-shaped bend 4 cm. below the pelvis. He could not straighten it out completely. Pressure on the kidney forced the liquid down to the bend, and it required increased pressure to force it through the bend. Here the bend was fixed, but in another case the bend could be straightened. In this case of intermittent hydronephrosis which was cured by nephropexy, lumbar incision was made, the kidney isolated, and likewise the ureter for 10 cm. Two cm. below the pelvis was a bend with dilatation above. In freeing the bend the renal vessels were in the way. By lifting the kidney up in place the bend straightened out and the pelvis evacuated its contents into the bladder. The pelvis was as large as a mandarin orange.

A third clinical observation was in a woman with movable right kidney who had presented the following symptoms for several years: When she was up and around she had pain, a tumor could be felt, and she passed a small amount of urine. The symptoms disappeared when she lay down, which she was compelled to do for an hour twice a day. On examination Tuffier found the kidney so displaced that the hilus pointed upward. He performed nephropexy, and found the pelvis and kidney dilated, but the ureter not dilated. It was thus evident that in the upright position the ureter was bent on the pelvis, and that the bend disappeared in the horizontal position.

These observations correspond with the experiments, and further with the observations, of Clement Lucas, Israel, Monod, and Rochet. It is evident that the mobility of the kidney causes the bend, and this is important because it gives a clue to the treatment.

Nephropexy is advised by Tuffier in all hydronephroses, not too voluminous, and is the method of choice in the great majority of intermittent hydronephroses. Tuffier reports 9 operations with 9 recoveries.

In our opinion the operation is effective only in beginning valve-formation, and useless when stenosis is present, and it is often impossible to make a diagnosis without examination of the seat of obstruction from within. There must consequently be some uncertainty when nephropexy alone is made.

There is a marked difference in shape between the empty and the full dilated floating kidney. The full kidney is round and tense; the empty kidney is flat and flabby. The color is whitish. Little hemorrhage follows denudation or incision. The suture for fixation is passed through the parenchyma, but not into the pelvis.

Nephropexy, however, is not effective in very voluminous sacs and when the drainage cannot take place through the ureter—that is, where the ureter is inserted too high up.

Landau states that intermittent hydronephrosis, where there is no gross pathological impediment to the passage of urine, it is not so rare as might be judged from the infrequency of reports of this condition in the literature.

The etiology of this condition was given by Landau as (*a*) bending; (*b*) torsion; (*c*) oblique insertion of the ureter. These conditions cause stagnation of the urine in the pelvis, dilatation of the pelvis, and then compression of the upper part of the ureter by the distended pelvis. These pathological conditions of the ureter are in many cases caused by floating kidney. Direct traction upon the ureter has also been reported as the cause of hydronephrosis in certain cases of prolapse of the uterus.

The amount of secreting substance left is very variable: more is found in the smaller tumors, but even in large tumors secreting kidney substance may be spread out over a large surface. In one of Simon's cases he could feel the calyces from the tenth rib to the crest of the ilium.

The ureter is small on account of atrophy from disuse. Its upper portion, which passes up through or in the wall of the pelvis, may be stenosed from pressure of the sac or from inflammation. Its opening into the pelvis is a narrow crescentic slit sometimes only 2 mm. in length, and often difficult to find.

Weigert describes an autopsy in a case of hydronephrosis: A vigorous man who had been treated in the hospital for chronic hemorrhagic nephritis finally died of uremia. Autopsy revealed right hydronephrosis the size of a child's head. A bend in the ureter 9 cm. below the kidney and 21 cm. above the bladder (the left ureter was normal and was 30 cm. long) had caused the hydronephrosis. The ureter below the bend was normal; above the bend it was dilated, first to 1 cm., and finally to 4 cm., in diameter. When the hydronephrotic sac was lifted up and the bend straightened out the clear fluid contained in the hydronephrosis could be squeezed down through the bend into the bladder (see Fig. 175). Weigert described this as a congenital anomaly. It is more likely that it was not congenital, but that the bend in the ureter was caused by the descent of a floating kidney, and that bending of the ureter at the end of its upper third caused the stenosis, which consequently was an acquired condition.

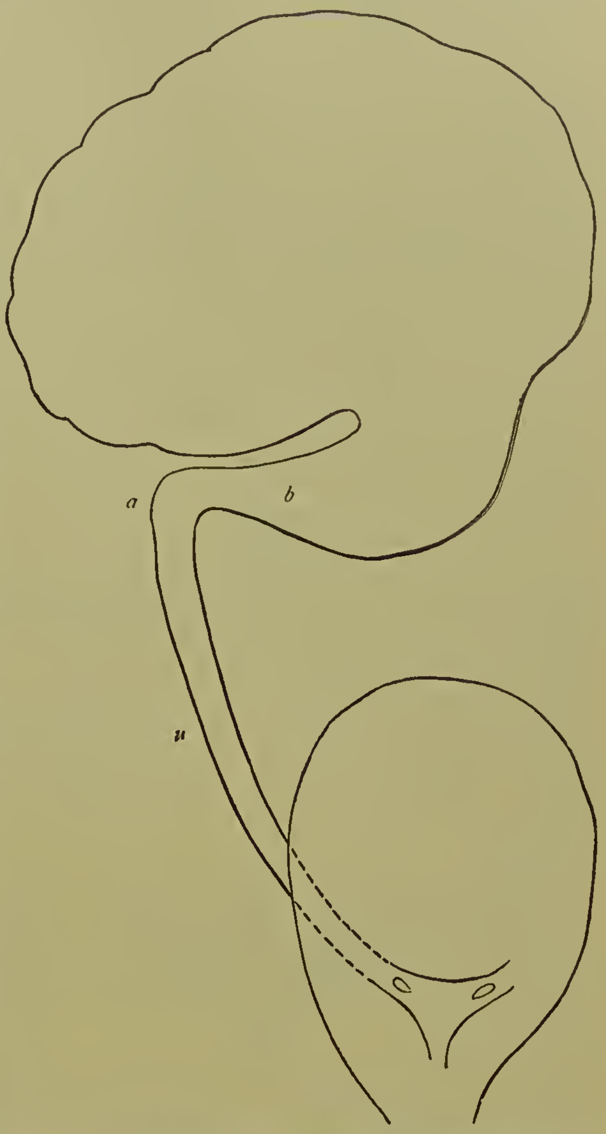

FIG. 175.—*u*, right ureter; *a*, bend; *b*, dilated portion of ureter above bend (Weigert-Virchow).

Operations for the Relief of Valve-formation.—As valve-formation always causes an intermittent or permanent impediment to the flow of urine, the pelvis of the kidney is in a state of hydro- or pyonephrosis. The so-called sac is accessible through the peritoneal cavity or by an extra-peritoneal operation through the lumbar region.

The first attempt to operate on the valve, after Simon's, which was unsuccessful, was made in 1890 by Trendelenburg, who opened the anterior wall of a large hydronephrotic sac by lateral laparotomy, saw the ureteral opening on the side of the sac, and divided the ureter down to the lower part of the sac, to the inner wall of which he sutured the divided borders of the ureter. The ureteral opening was thus displaced from the side to the bottom of the sac in order to keep the ureter patent. The result of this operation is uncertain, as the patient died from intestinal obstruction.

In 1891, Küster, in his celebrated case of resection of the ureter and implantation of the distal end into the pelvis, opened the hydronephrotic sac from the lumbar region, found the ureteral opening, and divided it through its course in the sac-wall, with the intention of stitching the divided border to the inner wall of the sac, as Trendelenburg had done. Before finishing this operation, however, he explored the ureter and found a stricture, which caused him to abandon the operation for valve-formation and to resect the stricture.

The valve-formation can be remedied by a plastic operation after previous opening of the dilated pelvis following lumbar nephrotomy. It is natural to select the lumbar region for entering the pelvis, because the operation is extra-peritoneal, and consequently there is no danger of infecting the peritoneal cavity, and because the lumbar incision gives the readiest access to the upper portion of the ureter. If it is possible in this manner to re-establish the flow of urine, we can save for future function what active kidney-tissue may be left, the danger of primary nephrectomy is avoided, and the patient may regain perfect health without urinary fistula. That this can be accomplished satisfactorily and promptly is illustrated by the following cases, the first of which, by Fenger in 1892, was the third attempt and the first successful operation for valve-formation:

Case 1.—Lady twenty-eight years, with valvular stricture or stenosis of the pelvic orifice of the left ureter in a somewhat floating kidney, with intermittent infected cystonephrosis of eight years' standing. An incision 10 cm. long was made from the angle of the twelfth rib and the extensor dorsi muscle obliquely downward and forward to the iliac crest above the anterior superior spine. Palpation of the kidney revealed neither fluid nor stone.

Nephrotomy by means of the Paquelin cautery and dilatation of the opening with forceps, so as to permit digital palpation of the pelvis and calyces. The calyces were dilated, and the pelvis was a large cavity extending from the lower border of the kidney with a round, smooth, soft surface. No stone could be felt nor could the ureteral entrance be made out. Examination with a steel sound gave similar negative results. A small bent metal probe was now passed into the pelvis, but the ureteral entrance could not be discovered. The posterior surface of the pelvis was now opened, and the borders of the wound grasped and held open with forceps for ocular inspection. The inner surface of the pelvis was seen to be normal in color and appearance. At the lower posterior portion of its inner wall was seen a small semicircular opening 4 mm. in length from above downward and 6 mm. in transverse diameter. The posterior border was convex, the anterior border straight. A metal probe introduced through this opening passed easily down into the bladder.

An olive-pointed bougie, No. 5 French, which was passed down, was tightly grasped by the ureter. By lifting up the pelvis the ureter could now be palpated. The wall was thin, and seemed liable to rupture unless great care was exercised. The bougie was removed, and on again lifting the pelvis and inspecting the entrance into the ureter it was seen that the ureter came off, not from the most dependent portion of the dilated pelvis, but from its posterior half or wall. Thus the anterior straight border of the ureteral entrance formed a valve or fold resembling the valve in a vein, which would close against the posterior wall of the opening when the pelvis was filled with urine or fluid to a slight or medium degree. A greater degree of dilatation, by pushing away the posterior wall of the pelvis, would reopen the entrance to the ureter. This accounted for the evacuation of urine containing pus after a period of occlusion of two days' duration.

To do away with this valve-formation the following operation was performed on the plan of the Heineke-Mikulicz operation for stricture of the pylorus (Fig. 176): An incision 5 mm. in length was made through the mucous membrane into the muscular wall or fold of the pelvis. The terminal points of the incision through the valve were now approximated by a fine silk suture, thereby changing the former vertical incision into a horizontal line. The entrance into the ureter was by this means made wider and more nearly circular.

A bougie, No. 11 French, was now passed through the opening in the pelvis 13 cm. down into the ureter, and the upper end brought up through the pelvis and out of the wound in the kidney, to keep the opening into the ureter dilated during healing of the wound. The incision in the pelvis was united by ten fine silk interrupted sutures passed through the pelvic wall, but not including the mucosa. The kidney was now replaced and fixed in normal position by nephropexy. The patient recovered without fistula and had no return of the cystonephrosis.

Case 2 (Fenger).—A married woman twenty-eight years of age, with aseptic remittent cystonephrosis in a movable kidney, of at least seven months' duration. On making a lumbar incision a thin-walled tumor presented in the wound, from which, upon opening of the sac-wall, a quart of clear straw-colored fluid was evacuated. Upon palpation the finger could not reach either the upper or the lower end of the sac, which was shaped like an hour-glass. The lower portion of the sac was round and larger than the fist, and its lower end extended down into the large pelvis. The ureteral opening could not be found on palpation or inspection with sunlight; search for the ureteral opening with a probe was also negative. The incision opening in the lower portion of the sac was sutured to the skin and the remainder of the wound united. The hydronephrotic cavity was packed with borated gauze, and two large drains introduced, one up and one down. The secretion from the sac gradually decreased until only four or five ounces passed through the fistula in the twenty-four hours, and she was sent to her home for further treatment.

Two months later the patient was sent back on account of infection of the sac. Six months later operation to reopen the ureter. Palpation prior to operation showed the sac to be considerably diminished in size, but the entrance to the ureter could not be found from within the sac. Thus the ureter was searched for and taken up below and outside of the sac. Incision over the lower portion of the sac, where the ureter was found and isolated. On making traction on the ureter and inspection of the sac a nipple-shaped projection with a depression in its center was seen on the side of the sac. Through this depression a long flexible silver probe passed into the ureter and down into the bladder without difficulty.

The ureter was now operated upon from within the sac in the following manner: A grooved director was inserted into the ureter, and the sac-wall, which was separated from the ureter by loose, movable connective tissue, was resected all around, and the borders of the unfolded ureter sutured to the borders of the wall of the sac. Thus free entrance of liquids from the sac into the ureter was positively secured. The large opening in the sac, 5 cm. in diameter, was now closed by sutures in the outer half of the wall which did not take in the mucous membrane or the kidney-tissue layer in the inner wall of the hydronephrotic sac. Only a small opening, the size of a lead-pencil, was left for drainage. The adhesions of the opening into the sac were first dissected off from the skin or from the border of the lumbar opening. Gauze was packed along the drainage-tube down to the opening in the sac, the abdominal wall united by buried and skin sutures, and the usual dressings applied. The renal fistula closed on the fortieth day after operation.

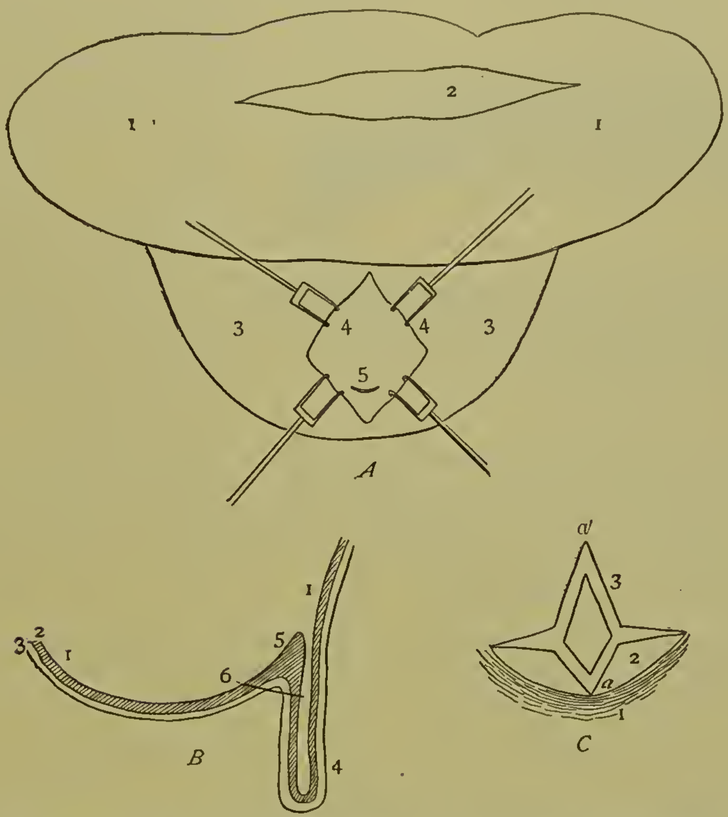

FIG. 176.—Illustrating operation for valve-formation. *A*, kidney and dilated pelvis: 1, kidney; 2, opening on its convex surface after nephrotomy; 3, dilated pelvis; 4, with opening on its posterior surface from pelviotomy; 5, opening of the ureter into the pelvis, a small transverse crescent-shaped slit. *B*, dilated pelvis and ureter, showing valve-formation: 1, pelvis; 2, mucous membrane; 3, muscular and external coat; 4, ureter; 5, valve; 6, line of incision dividing valve. *C*, valve seen from the pelvis and divided to illustrate the plastic operation: 1, inner wall of pelvis above the ureteral opening; 2, ureteral opening; 3, the divided valve; *a* and *a'*, the corners of incision to be united by a suture.

In this case a slightly atrophic ureter ran obliquely on the antero-lateral wall of the sac for 3 cm. There was no stenosis. The ureteral opening could not be seen or found from the inside of the sac until the ureter below the sac had been laid bare, so that the place of entrance could be seen when traction was made on the ureter.

This case conforms to the law that a lumbar renal fistula does not persist when the ureter is patent. Whether it is worth while to save a kidney with a daily secretion of only three ounces is a question not to be decided until future observations have taught us more about the subject than we know at present—namely, where to draw the line between a valuable and a valueless organ.

A somewhat different method of operating on this valve has been suggested by Küster, but has not yet been tried (see Fig. 177). He reports a case in which he divided the valve longitudinally. He proposed to freshen each flap and unite it by sutures to the freshened inner wall of the sac. Küster was not able to carry out this plan, because he found, in addition to the valve, a stricture in the ureter 2 cm. below the pelvis. This condition caused him to resect the upper 3 cm. of the ureter and unite the upper end of the distal portion of the pelvis by a plastic operation.

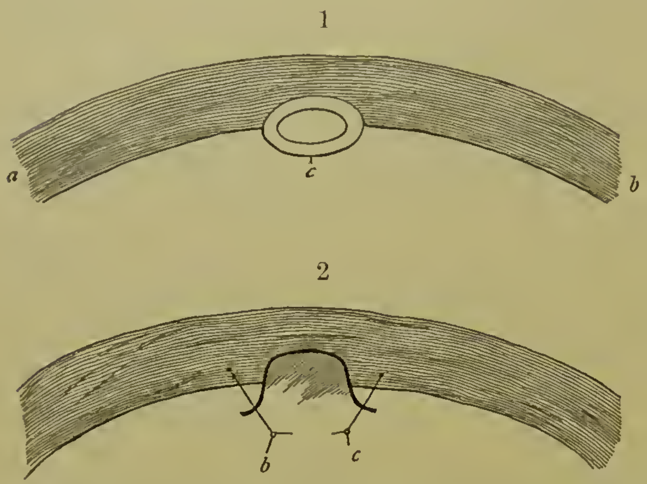

FIG. 177.—1. Küster's intended operation on the valve (same as Trendelenburg's); *a*, *b*, wall of sac; *c*, transverse section of ureter. 2. *b*, *c*, the ureter divided on its anterior surface; near *b* and *c* are sutures uniting the borders of the divided ureter and the wall of the sac.

The second successful operation was performed on August 14, 1893, by Herman Mynter.

Mynter's Case.—Man, twenty-five years of age. Valvular stricture of pelvic orifice of ureter. Intermittent hydronephrosis for twelve years; periodical attacks of pain every two or three months in right lumbar region. Diagnosis: right renal calculus producing occlusion of ureter. Exploratory nephrotomy. No stone found. Ureter permeable, but presented valve-formation at pelvic orifice. Plastic operation on valve. Gauze drain; recovery without fistula.

The operation for valve-formation can best be done by the extra-peritoneal lumbar incision. The dilated pelvis or hydronephrotic sac is easily found and opened by a longitudinal incision. The opening of the ureter into the sac should be looked for, but cannot always be found, as in some cases it is very narrow. In such cases it may be located by incising the ureter below the sac and passing a probe upward toward the pelvis. The valve or inner wall of the ureter, running in the sac, is now divided longitudinally from the opening in the sac, and the resultant wound treated in one of the three following ways:

(*a*) By turning the flaps out and uniting them to the inner wall of the sac by sutures (Trendelenburg, Küster);

(*b*) By drawing the corners of the longitudinal incision together with one suture, transforming the longitudinal into a transverse wound (Fenger);

(*c*) By uniting the wound longitudinally with numerous fine silk sutures, "taking in the outer two coats of the ureter and sac and avoiding the mucous membrane" (Mynter).

In one case Kelly emptied a large hydronephrosis by catheterizing the ureter. The patient had an obscure tumor the size of a quart measure on the right side of the abdomen. It was movable, elastic, and painless. He introduced the long renal catheter until a little fluid escaped, and then by pressure on the tumor emptied it completely, confirming the diagnosis of large hydronephrosis.

Strictures of the Upper Portion of the Ureter.—It has been seen in the description of valve-formation that a stricture often forms in the portion of the ureter located in the wall of the dilated pelvis; but this stricture is treated by the operation for valve-formation as described above. Independent strictures below the pelvis require different treatment. If such strictures are single and accessible, they can be operated upon with a view to re-establishing the continuity of the canal.

Outside of observations at the post-mortem table little attention has been called to the question of strictures of the ureter, because in the cases of cystonephrosis formerly operated upon, the kidney was opened or extirpated and no attention was paid to the ureter.

From the post-mortem table we know that multiple strictures can be found as a result of chronic inflammation of the canal, as in the instance depicted by Hallé, mentioned by Tuffier, in which not less than three strictures were found, the ureter between the strictures being dilated.

As a result of traumatism limited strictures have been seen to be formed, as in the cases of Pye-Smith and Sollier. Pye-Smith reports the following case of stricture of the ureter and dilatation of the kidney, apparently of traumatic origin :

Pye-Smith's Case.—Male, twenty-four years of age; farrier. Never had stricture. Two years before kicked on left side " under short ribs," and passed blood with urine several days. In bed three days. No difficulty in passing water. On examination a large tumor was found occupying left half of abdomen. The urine contained a trace of albumin. August 22, 1871, the tumor was tapped, and six and a half pints of a reddish fluid containing pus and red blood-corpuscles evacuated. He died six weeks later. On autopsy the ureter was found to be dilated to a circumference of 4 cm., then contracted so as not to admit the smallest probe. No impacted calculus; no sign of recent inflammation. The disease was probably traumatic and the ureter probably injured. During the two years following the canal was gradually contracting and forming stricture; consequently, the pelvis of the kidney gradually expanded.

Sollier's Case was one of traumatic stricture of the ureter in a man of forty-five who in 1870 sustained a traumatism by a kick from a horse in the left hypochondrium. The injury was followed by pain in the left side, gradually increasing for nine years, when symptoms of nephritis appeared and the patient died from uremia. At the autopsy it was found that the left kidney had been transformed into a number of " cavities the size of nuts." The calyces, pelvis, and upper portion of the ureter were dilated. In the middle portion of the ureter was found a " cicatricial stenosis."

Little is also known as to the frequency of strictures, but it may possibly be concluded from the frequency of permanent urinary fistulæ following nephrotomy that they are not of infrequent occurrence. Tuffier states that fistula followed nephrotomy in 45 per cent. of the cases collected, and we are forced to believe that the permanency of the fistula is caused by imperviousness of the ureter either from valve-formation or from stricture. How often this is caused by a stone lodged in the canal, and how often by a stricture without stone, we will not know until the ureter has been investigated by probing from above in a large number of nephrotomies. From the statistics collected by Tuffier, which show that nephrotomy for calculous pyelitis was followed by 34 per cent. of fistulæ in 114 cases, and that nephrotomy for non-calculous pyelitis was followed by 57 per cent. of fistulæ, we cannot draw any certain conclusions as to the frequency of stricture in non-calculous pyelitis as compared with the frequency of stones in the ureter; but it is likely that strictures are common.

As to the frequency with which strictures occur in different parts of the ureter, we have a statement from Tuffier to the effect that in 29 instances of congenital hydronephrosis a stricture was found in the upper end in 15 cases and at the lower end in 14. In Sollier's case of traumatic stricture it was located in the middle portion of the ureter.

It is probable that only strictures situated in the upper abdominal portion of the ureter are accessible for operative interference. Such strictures have been dealt with by dilatation or operation.

Dilatation by bougies from above has been reported by Alsberg.

Alsberg's Case.—Lumbar nephrotomy in a case of left hydronephrosis. For ten days all urine passed through fistula, from which it was concluded that the other kidney was defective in function. Ureter successfully dilated from the wound by thin bougies. After several days urine passed through bladder. Some months later the fistula closed. The hydronephrosis did not reappear.

Dilatation from below has been practised by Kelly, who found in a case of pyuria from gonococcus infection the region about the left ureteral orifice puffy, red, and edematous, and also a stenosis in the vesical portion of the ureter, through which he finally succeeded in passing the catheter, whereupon 160 c.cm. of purulent urine escaped.

Only 4 operations have as yet been performed for stricture—namely, 1 by Küster and 3 by Fenger—and the successful results were reached in each case by a different method. All were strictures in the upper part of the ureter near the pelvis of the kidney. The methods employed were longitudinal ureterotomy through the stricture and transverse union (Fenger 2 cases), resection of ureter and implantation of the distal end into the pelvis (Küster), and longitudinal ureterotomy, excision of stricture from within, and transverse union (Fenger).

Longitudinal Incision (Fenger).—When the stricture is not too extensive it is divided longitudinally after opening the ureter above or below. The upper and lower ends of the longitudinal wound are then brought together by folding the ureter upon itself. The remainder of the wound is united by sutures through the outer and middle coats, thus transforming the longitudinal into a transverse wound.

Case 1 (Fenger).—A farmer forty-seven years of age. At the age of thirteen, in jumping from a horse to the ground, he sustained a violent jerk on account of miscalculation of distance, his feet not having touched the ground, while his hands still retained hold of the hames. This injury was followed by sharp, constant pain in the left side, which obliged him to remain in bed for a month. He had no special inconvenience until ten years later, when, after over-exertion, he had an attack of sharp pain in the left side; at this time he was in bed about a week. One year later he had a third attack, which was attended by pain and soreness and obstinate constipation. For the next ten or fifteen years he had four or five attacks a year, lasting from two to three days. The last attack occurred October 22, 1892.

The patient was well nourished. In the left hypochondrium could be found a tumor, immovable, hard, and not nodular, which extended 5 cm. below the ribs and to within 8 cm. of the umbilicus. The urine contains a little pus. Diagnosis: nephrolithiasis in the infundibulum or pyonephrosis from stone or obstruction in the ureter.

November 26: For the past week there has been more pus in the urine, indicating that the contents of the pyonephrosis have been evacuated through the ureter. Examination in narcosis showed that the tumor had disappeared. The patient was anesthetized with ether, and placed on the right side with a pillow under the loin. An incision was made from the angle of the twelfth rib 15 cm. downward and forward to within 2 cm. above and anterior to the crest of the ilium. The adipose capsule of the kidney was so adherent that when it was removed the fibrous capsule was stripped off also. The exposed surface of the kidney was not shining, but was red, velvety, and nodulated, each nodule forming a flat prominence about 2 cm. in diameter. Each prominence was compressible and resembled a dilated calyx. The kidney was of normal size. After excision of a piece of the kidney substance for microscopic examination the dilated cavity of pelvis and calyces was opened, and a jet of urine tinged with pus came out over the wound.

Digital exploration revealed that the globular protuberances were dilated calyces which communicated with the pelvis, forming a common cavity. A reasonable amount of kidney substance appeared to be present, especially in the lower part. The wall of the pelvis was smooth and there was no stone or gravel. The entrance to the ureter could not be found. The kidney was therefore lifted up over the border of the twelfth rib. A longitudinal incision 2 cm. long was made in the exposed pelvis and the edges held apart with retractors. No ureteral entrance could be seen or felt.

The external wound was now prolonged downward for 4 cm. to within 2 cm. of the anterior superior spine of the ilium. The ureter could now be seen as a string or band, not dilated. Its upper end was imbedded for 1 cm. in cicatricial tissue. A longitudinal incision 1 cm. long was made in the ureter about 2 cm. below the pelvic opening. A metal probe introduced into the ureter through this incision passed easily into the bladder. In passing it upward, however, a stricture was found just below the point of entrance of the ureter into the pelvis. The ureter was adherent to the surrounding adipose tissue at this point. The adhesions were separated by the handle of the scalpel and the stricture opened by a longitudinal incision on the probe as a guide. The opened stricture was seen to be 1 cm. long. In the remainder of the ureter a diffuse atrophic narrowing had occurred.

The patency of the ureter was re-established by uniting the wall of the ureter below the stricture to the pelvic wall, leaving the stricture as a loop (Fig. 178).

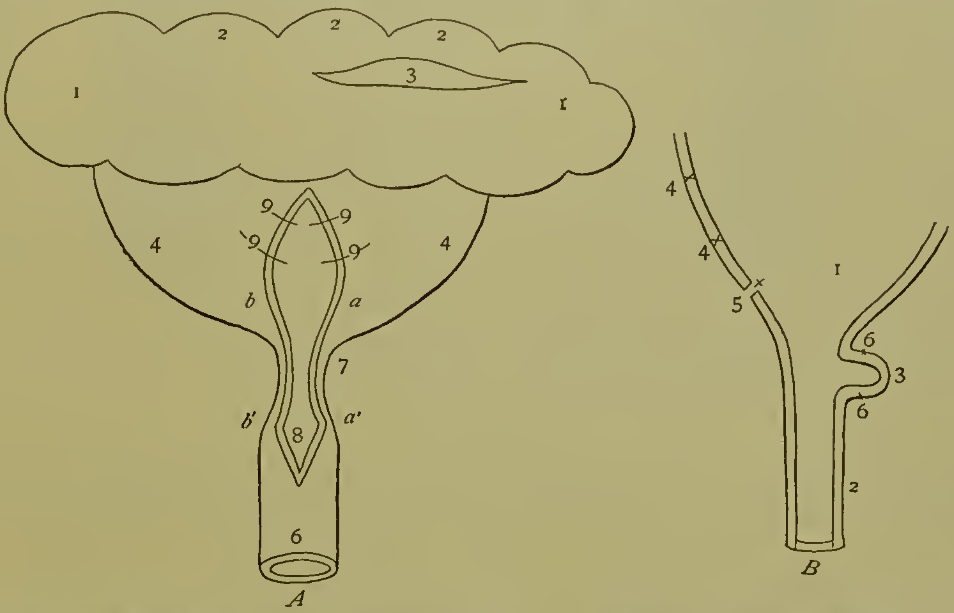

FIG. 178.—Illustrating operation for stricture of ureter. *A*, sacculated kidney, dilated pelvis, ureter with stricture at its upper end: 1, kidney; 2, sacs corresponding to dilated calyces; 3, nephrotomy; 4, dilated pelvis; 5, opening in posterior surface of pelvio-pelviotomy wound; 6, ureter below stricture; 7, stricture in upper end of ureter; 8, opening in ureter below stricture, extending up through the stricture into the pelvis; 9, sutures closing the upper half of the wound in the pelvis; *a*, *a′*, and *b*, *b′*, points of incision in ureter and pelvis to be united by sutures after folding the ureter upon itself at the place of stricture.

B, pelvis and ureter after union by sutures: 1, pelvis; 2, ureter; 3, fold of ureter at place of stricture; 4, sutures of wound in pelvis; 5, place of sutures between points *a*, *a′*, and *b*, *b′*; 6, 6, additional sutures, as many as needed to close borders of the fold formed by approximations of *a* to *a′* and *b* to *b′*.

The upper part of the wound in the pelvis was closed by sutures. No bougie was left in the ureter. The wound was drained by a large tube passed into the wound in the kidney 7 cm. upward to the upper corner of the kidney. A smaller drain was passed down to the pelvis and ureter. Gauze strips were packed around the anterior and posterior surfaces of the kidney and 7 cm. down along the ureter. The divided muscles of the abdominal wall were then united, with the exception of the lower 7 cm., which were packed with gauze. The external wound was united by sutures and dressed in the usual way. The operation occupied two hours. The patient was weak at its close. The next day he passed naturally urine containing no blood. The pain decreased and the amount of urine in the dressings became progressively less. November 29 to 31 blood was found in the urine, which showed that the ureter was patent from the third day after the operation.

January 5, 1893, the wound was closed. The patient was well and strong, suffered no pain, and could walk around all day. No tumor could be made out. Pressure in renal region was painless. The urine at this time was normal in quantity, forty-six ounces, and upon microscopical examination of the sediment only a few pus-cells could be seen. No trace of albumin could be found in the urine. The patient has gained flesh, and is much better than before the operation. Four years later he was accepted as a good risk by a life insurance company.

CASE 2 (Fenger).—A man twenty-one years of age. A year previous, in 1893, he had contracted gonorrhea, which was followed by inflammation of the neck of the bladder. Three months later he had a sudden severe attack of right renal colic, which lasted seven hours. Examination of the urine at this time revealed marked hematuria and pyuria. For four weeks he had recurrent attacks of renal colic, lasting from three to ten hours, every other day.

Under enforced rest and rigid diet the pus in the urine slightly decreased. On March 8, 1894, he had a severe attack of renal colic, which persisted for three days, and a large hard tumor could be felt on the right side.

Lumbar nephrotomy three days later. The lower two-thirds of the kidney were found to be dilated and the large sac contained about two pints of urine and pus. The upper third of the kidney contained good secreting tissue. No calculi were found, no tuberculosis. The patient's condition did not warrant search for the ureter.

After the first eight days the right ureter was patent for ten days, as was proven by the presence in the bladder-urine of pyoktanin, which had been injected into the fistula. The ureter then closed, and its patency could not be re-established. Three weeks after the operation about two hundred and fifty small, well-formed calculi about the size of No. 6 shot were passed through the fistula. The patient wore a silver urinal, and passed through the bladder about thirty ounces of urine in the twenty-four hours, and about the same through the fistula.

On September 17 operation for relieving occlusion of the ureter. The granulation-tissue around the fistulous opening was removed with the sharp spoon. A lumbar incision was made through the fistula downward and forward and the kidney laid bare. The incision was prolonged downward 5 cm. The surface of the kidney was normal in color, the kidney enlarged and lobulated. The adhesions were slight and were easily broken up. The pelvis was found to be dilated. Search for the ureter was now made, and it was recognized below its pelvic origin, and exposed for about 4 cm. from the pelvis. An aspirator needle was introduced into the dilated pelvis of the kidney and thin bloody fluid withdrawn. The pelvis was now opened on its posterior surface. A futile attempt was made to locate the pelvic orifice of the ureter from the pelvis. A small depression, however, was noticed, which indicated the point of entrance.

A longitudinal incision was now made in the ureter about 2 cm. from the pelvis below the stricture; a flexible sound introduced through this incision passed easily down into the bladder. The lower portion of the ureter was somewhat contracted from disuse. A fine silver probe was next introduced through the incision and passed upward; the location of the stricture was thus found to be at the point where the ureter emerges to form the pelvis. With considerable difficulty the probe could be pushed through the stricture into the pelvis. With the probe as a director a longitudinal incision was now made through the stenosed portion of the ureter between the two openings. The upper and lower borders of the wound were brought together by silk sutures, thus folding the ureter upon the pelvis. The small longitudinal opening in the ureter was left unsutured.

Before closing the wound in the pelvis an incision was made through the convex outer border of the kidney into the dilated calyces, and the upper end of a flexible bougie, which had been previously passed down into the ureter through the opening in the pelvis, was passed up from the pelvis through the convex surface of the kidney and out of the lumbar wound, to remain twenty-four hours and then be removed. A piece of kidney tissue was also removed for examination.

The patient made a good recovery, but the fistula persisted.

At an operation seven months later the cause of the persistent fistula was found to be valve-formation at the upper end of the lower branch of the ureter, which prevented the urine from the lower half of the kidney from passing down into the pelvis. The pelvic end of the ureter was open, and permitted free passage of the urine from the upper half of the kidney into the bladder, thus demonstrating that the previous operation for stenosis of the ureter at its pelvic orifice had been effective.

Resection of the ureter and implantation of the distal end into the pelvis was done by Küster in the following case:

The patient was a boy eleven years of age who had had a lumbar nephrotomy six months previous for open left hydronephrosis. The operation was followed by vesical anuria and permanent fistula. On May 25, 1891, the boy was seen by Küster. Two months later Küster re-established the patency of the ureter by the following operation: A lumbar extra-peritoneal incision was first made into the sac, but the ureter could not be found. The lower end of the sac—the dilated pelvis—was then incised, on the upper border of which was seen a layer of kidney-substance the thickness of a thumb.

The ureter could now be seen running several centimeters in or upon the posterior wall of the sac and terminating in a slit in the pelvis. On attempting to introduce a fine probe into the ureter a stricture was encountered 2 cm. below the pelvis.

As a cure seemed impossible without removing the stricture, the ureter was transversely divided below the stricture and at the entrance to the sac. The ureter was now united to the pelvis by dividing the upper end of the ureter longitudinally, unfolding the divided end, suturing it to the opening into the sac, and closing the remainder of the wound in the pelvis by catgut sutures (Figs. 179, 180).

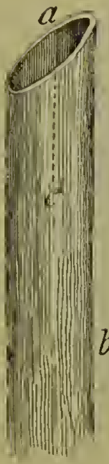

FIG. 179.—Küster's operation for implantation of the ureter into the sac (pelvis): *a*, upper end of *a*; *b*, ureter running in the wall of the sac; *a*, *c*, slit in upper end of ureter.

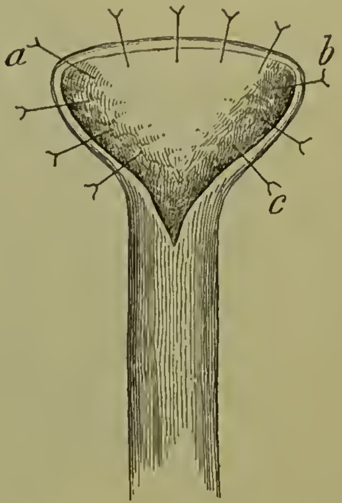

FIG. 180.—The divided end of the ureter unfolded, and in the extent of *a*, *b*, *c* sutured to the wall of the sac (Küster).

The next day some bloody urine escaped into the bladder, but ordinarily the urine passed out through the lumbar fistula. From this time more and more urine passed into the bladder, until four months after the operation as much as 100 c.cm. passed in the twenty-four hours.

Four months later the fistula was closed by curetting, dilating, and closing the canal by tier sutures. In the first twenty-four hours after this operation the patient passed 1300 c.cm. of bloody urine from the bladder. He recovered, but with a lumbar hernia which had to be held in place with a bandage; the fistula remained closed. The boy was able to work and had excellent health. The urine contained a few pus-corpuscles and a small quantity of albumin.

Longitudinal Ureterotomy, Excision of Stricture from Within, and Transverse Union (Fenger).—A woman, thirty-two years of age. At the age of seventeen, after jumping from a wagon to the ground, she at once experienced pain in the right side immediately under the ribs, so severe that she fainted. This was followed by intermittent attacks of pain in the right hypochondrium lasting from a few hours to several weeks.

After a miscarriage in 1893 the attacks increased. The patient was somewhat emaciated; abdominal examination revealed an obscurely defined tumor in the right side of the abdomen, close to the umbilicus, 10 cm. long and 7 cm. wide, which was dull upon percussion. The tumor was readily movable to the median line and backward to the normal position of the kidney, but attempts to move the tumor caused considerable pain. The urine contained neither albumin nor sugar. During the attacks of pain she urinated frequently, but passed only small quantities of urine.

Cystonephrosis of right movable kidney, probably due to stone in kidney or pelvis, and probably infected, was diagnosed, and exploratory incision for drainage and possible removal of stones advised.

On August 6, 1895, a lumbar incision was made (Fig. 181). The kidney was large, with but little perirenal fat, and was freely movable. After isolation of the dilated pelvis, in which no stones could be felt, the ureter was laid bare, whereupon a nodular mass was felt 5 cm. below the pelvis. The pelvis was then incised longitudinally and about an ounce of urine escaped. Upon manipulation of the ureter four stones were squeezed up into the pelvis and removed through the wound. A sound passed down from the pelvis into the ureter was arrested 6 cm. below the pelvis, at a point where a somewhat soft thickening was felt on palpation. A longitudinal incision 1 cm. long was now made into the ureter, through and below a transverse valvular stricture (Fig. 182). A probe inserted through the opening in the ureter below the stricture passed easily down into the bladder. By holding the longitudinal wound open and stretching this part of the ureter over the index finger the valvular stricture was excised from within the ureter with scissors, leaving the muscular and external coats of the ureter intact. A plastic operation on the ureter was now performed—namely, longitudinal division of the stricture and transverse union of the longitudinal wound (see Fig. 183).

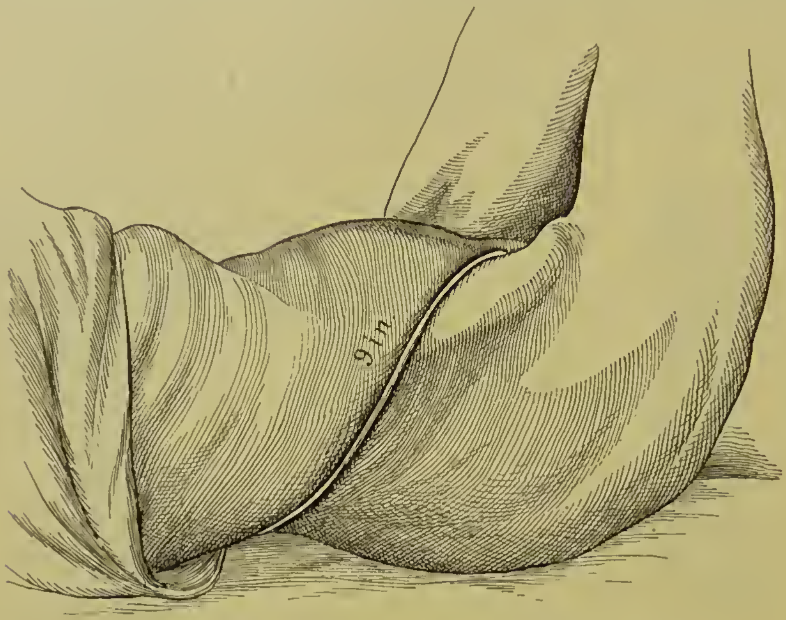

FIG. 181.—Line of incision when wound was nearly healed.

This method of operating for ureteral stricture is preferable to resection of the strictured part of the ureter (Küster's operation), for the following reason: It is a more economical operation, and preferable when elongation of the ureter is not sufficient to permit the two cut ends of the ureter, after excision of the stricture, not only to come into contact, but even to permit of closure and invagination without stretching.

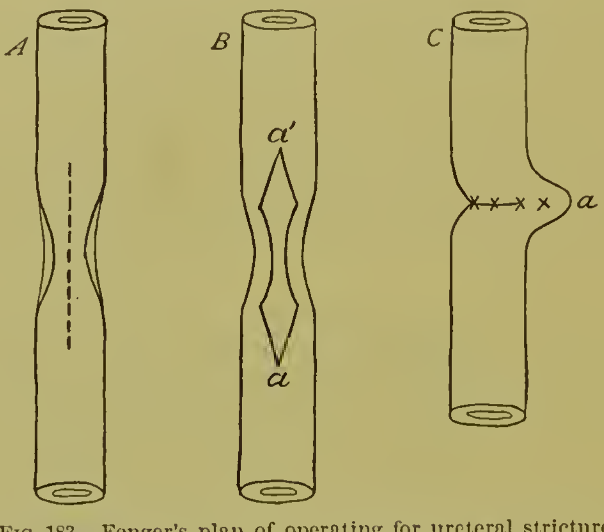

FIG. 183.—Fenger's plan of operating for ureteral stricture on extra-peritoneal surface of ureter: (A) ureter stricture and line of incision; (B) opening through the stricture extending into the proximal and distal portion of the ureter, the extreme ends of the incision *a* and *a'* to be united; (C) ureter after suturing; *a*, the bend at the site of the stricture.

FIG. 182.—Circular valve in the ureter; natural size.

A flexible bougie was passed from the wound in the pelvis into the ureter and left there. The wound in the pelvis was left open. The calyces were moderately dilated, and in one of them a small stone was found and removed. Rubber drainage-tubes were inserted, one down to the wound in the ureter, and another to the pelvis of the kidney. These tubes were surrounded with gauze. The external wound was closed with heavy silk sutures.

Microscopical examination of the valve showed that it consisted of firm fibrillary connective tissue, with normal distribution of vessels, no muscular fibers of the wall extending into it (Fig. 184).

The free border of the valve looking into the lumen of the ureter was clad with stratified cylindrical and cuboid epithelium. The border of the valve was folded, and thus a cross-section through the bottom of a fold showed an island of cuboid epithelial cells.

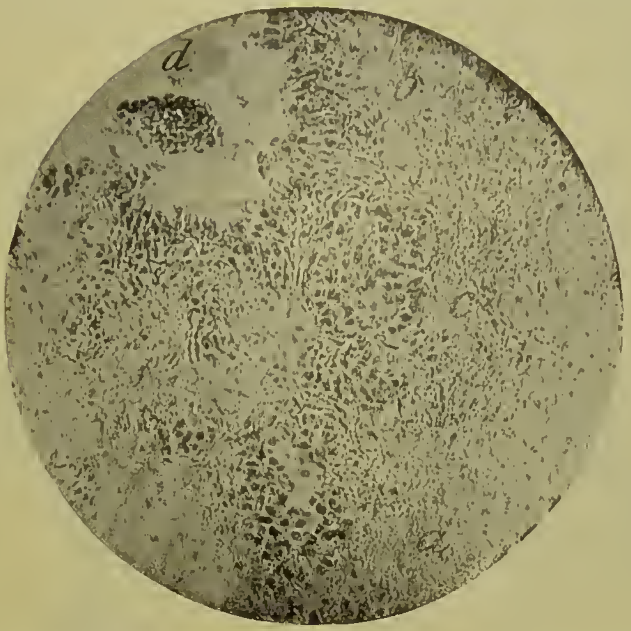

Fig. 184.—Microscopic section of valve: *a*, firm fibrillary connective tissue, with normal distribution of vessels; *b*, stratified cylindrical and cuboid epithelium, lining free border of valve; *c*, island of cuboid epithelial cells; *d*, lumen of ureter.

On the fourth day the gauze was almost dry, indicating that the urine had passed along the bougie through the ureter. On the sixth day the amount of urine passed was thirty ounces in twenty-four hours, and on the following day the bougie was removed from the ureter. Six weeks after the operation the fistula was closed and the patient left the hospital, and has since remained well.

Exploration of the ureter with the sound led to the detection of the stricture, a valve, which was excised through a longitudinal opening in the ureter at its seat. The author considers this operation preferable to excision of the entire wall of the ureter and invagination after Van Hook's method, as it is followed by the least possible shortening of the canal. This point may be of importance if more valvular strictures should have to be operated upon.

INFLAMMATION OF THE URETER.

Ureteritis very rarely exists isolated, but almost always together with inflammations in the bladder or the pelvis of the kidney. It has the same causes as the inflammations of the bladder and the pelvis of the kidney—namely, as predisposing causes, arterio-sclerosis, incomplete retention of urine in prostatic patients, and retention of urine in the ureter from obstructive causes in the small pelvis so common in women. The retention causes stagnation and gives the microbes time to develop, and the arterio-sclerosis lowers the vitality of the epithelium, favoring infection. Congestion in the whole urinary tract by exposure to cold on the skin or paraplegia from diseases or injuries of the medulla may also cause retention and lower the vitality of the mucosa. Infection only rarely takes place as a metastasis from microbes in the circulation.

Infectious diseases and pyemia only exceptionally come into question as determining causes. Most often the microbes are brought in directly from without. In traumatisms to the ureter and the kidney they may be brought in by an unclean catheter. In exceptional cases only, an abscess in the small pelvis may communicate with the ureter or bladder and cause infection with pus-microbes or the colon bacillus. The stagnating urine behind a hypertrophied prostate or a stricture of the urethra is an excellent culture-soil for the microbes that invade from without. Gonorrhea is followed by ascending infection in 2–3 per cent. of the cases only. Ascending infection following childbirth finds a ureter prepared by compression to receive infection from suppurating genitals and unclean catheters. Pelvic inflammations, pyo-

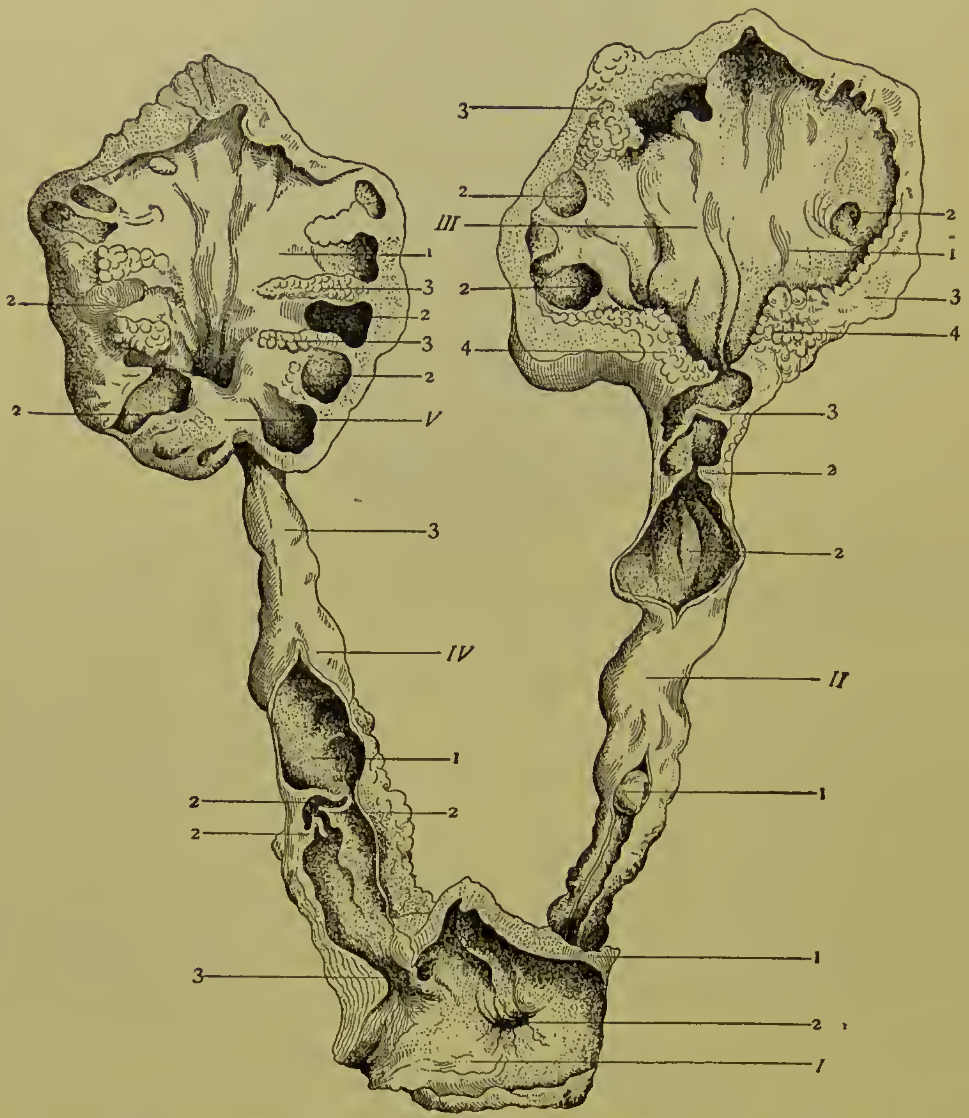

FIG. 185.—Double uretero-pyelonephritis, with stricture and dilatation of the ureter (Musée Guyon, Specimens Nos. 158 and 159).

I. Part of the opened bladder; 1. Hypertrophic vesical wall; 2, vesical opening of left dilated ureter; 3, vesical opening of right ureter.

II. Left ureter opened and unfolded in its upper portion; split in its lower portion: 1. Stone arrested in lower third of canal; 2, lumen of dilated ureter, constricted by two valvular folds, 3, 3.

III. Left kidney opened on its convex border: 1. Cavity of dilated pelvis; 2, openings to dilated calyces; 3, renal tissue; 4, fibro-lipomatous deposits.

IV. Right ureter opened in its lower half: 1. Cavity of the canal; 2, imbricated valvular folds; 3, narrowed upper portion.

V. Right kidney opened on its convex border: 1. Cavity of pelvis; 2, calyces; 3, fibro-lipomatous septa.

salpinx, or abscess of the broad ligament may also prepare the way, either by pressure on the ureter or by lymphangitis extending to the ureteral wall (Hallé). The balsamic irritants cause transient aseptic inflammation only. The microbes that most commonly enter are the pus-microbes, the colon bacillus, and the gonococcus, the latter rarely alone, but usually preparing the way for one or several of the others. Albarran (cited by Tuffier) found in 25 cases of pyelonephritis the colon bacillus alone in 16, streptococcus alone in 2, and mixed infection in 7 cases—namely, streptococcus, colon bacillus, micrococci, and other bacilli. The microbes from the bladder may ascend into the ureter from reflux of the urine during vesical contractions, from active locomotion of microbes or migration by diffusion, or antiperistaltic movements of the ureter.

Tuffier calls attention to the fact that in retention in the bladder with distention of the ureter the uretero-vesical sphincter becomes insufficient, facilitating regurgitation of infected urine from the bladder or diffusion of microbes up into the urine stagnating in a dilated ureter. Such urine, if it contains albumin, is an excellent culture medium, especially where the vitality is lowered by arterio-sclerosis or where painful cystitis causes frequent contractions of the bladder.

Infection through the circulation rarely attacks a ureter directly, but, having located in the kidney, from there secondarily may cause a descending infection of the ureter, which generally occupies the upper third of the canal only.

The inflamed ureter in acute cases, besides the usual signs of acute inflammation, may, according to Hallé, show multiple superficial ulcers in the mucosa. The deeper of these may result in consecutive stenosis.

The condition of the ureter presents two different aspects in the chronic forms. We distinguish between ureteritis with dilatation and ureteritis without dilatation, but with considerable thickening of the wall. The vesical opening of the ureter seldom undergoes change, with the exception that it may be insufficient. In patients with hypertrophy of the prostate Tuffier has found sclerosis of the orifice.

Ureteritis with Dilatation.—The ureter is enlarged and elongated from the size of a finger to that of an intestine; a circumference of 10 cm. has been seen. It is not uniform in caliber, but is often irregularly nodulated, showing dilated portions between multiple, sometimes very narrow, strictures. Secondary phosphatic stones often form, and are arrested at the seat of the narrow strictures. The wall is thickened and hard at the place of the strictures, thinned and transparent in the dilated portions. The mucosa is red and thickened, rarely ulcerated, and liquid injected passes down with difficulty. The strictures are usually located in the upper, middle, and lower portions of the ureter, at the neck of the pelvis, and 7 or 8 cm. above the bladder. The strictures are formed by thickening of the muscularis and are clad with mucosa often devoid of epithelium.

Ureteritis without Dilatation.—The ureter is not elongated; its caliber is diminished, so that it forms a thick, straight, hard cord with a thick wall of sclerosed fibrous or fibro-lipomatous tissue, due to the chronic periureteritis. The hardened cord can sometimes be felt upon abdominal palpation. The lumen is either uniform or presents here and there local retractions. These strictures consist of sclerotic connective tissue with no hypertrophy of the muscularis. The mucous membrane is usually deprived of its epithelium; hence the tendency to obliteration when the kidney is removed and no pus or urine passes down.

Symptoms.—The symptoms are the same as those of pyelonephritis, and it is very difficult to differentiate the symptoms of disease of the ureter from the concomitant disease of the pelvis and kidney above. Pain may be felt along the course of the ureter, dull persistent pain below the kidney, tenderness on pressure by rectal, vaginal, or abdominal palpation. The urine is uniformly whitish, often acid, and may contain more pus than would occur from a cystitis alone. Upon standing in a glass or test-tube there is a sediment of pus at the bottom, above which the urine is thin and milky. But this is characteristic of pyelitis rather than of isolated ureteritis.

Crises of renal retention of urine form a most valuable symptom in the cases of multiple valves or strictures in the ureter, and signify, as Hallé has pointed out, the characteristic symptoms for temporary occlusion of a valve. If the disease is unilateral, the pus disappears suddenly from the urine, which remains clear for three or four micturitions, or even for a day or two. Following the pain of the crisis, the distention may be felt by abdominal palpation either as a swelling of the corresponding kidney or of the ureter at the brim of the pelvis. He advises that the bladder be left undisturbed, if possible, during these attacks of fever and pain. The swollen ureter may be felt as a tender cord through the rectum or the vagina, extending upward, backward, and outward in the direction of the ureter, but may be difficult to distinguish from a pyosalpinx or a tuberculous vas deferens. Upon abdominal palpation a nodulated tender cord may rarely be felt.

An acute ureteritis may disappear with the cystitis or pyelitis that caused it. Even chronic cases may improve temporarily after successful treatment of prostatic hypertrophy or strictures. Recovery may take place by obliteration of the ureter if either the kidney is removed or is also obliterated. This is especially apt to take place in ureteritis without dilatation, while a dilated suppurating ureter after nephrectomy is apt to continue to discharge pus and eventually to require ureterectomy.

Cystoscopy and catheterization of the ureter are of immense value in the **diagnosis,** and may be the only ways in which a positive diagnosis can be made, especially in cases where other symptoms, except the flow of pus from the ureteral opening, are absent.

Treatment may be either preventive or curative. We must treat the urethral strictures, the cystitis, the prostatic hypertrophy, to prevent or reduce the inflammation of the ureter. Antiseptic internal remedies, salol, borax, etc., may have some if only temporary effect. Double pyelitis in old prostatic patients cannot be helped by direct surgical procedures, which, on the other hand, may be most effective when the disease is unilateral (Hallé).

Local treatment by means of catheterizing the ureter and intra-ureteral injections is a most effective and rational procedure, and we owe to Kelly the introduction of this treatment, which in his hands has proven eminently successful.

In case of a woman with pain in the right kidney Kelly passed a renal catheter into the pelvis of the right kidney, but nothing flowed. The catheter was left in position, and was afterward, as nothing escaped, connected with an aspirator bottle, and 280 c.cm. of thick yellow pus withdrawn. In several other cases he had a similar experience.

Ureteral and renal pyuria are treated, according to Kelly, by the new method in three ways: 1. Evacuating the pus; 2. Washing out the inflamed ureter and pelvis; 3. Dilating the stricture or removing the calculus.

The treatment begins with the evacuation of the pus, which establishes the diagnosis, and now the catheter can be left *in situ* for drainage or reintroduced at intervals of from one to three or four days. Kelly prefers not to leave it in permanently. For washing out the ureter and the pelvis of the kidney he prefers bichloride of mercury 1 : 10,000, or boracic acid one-half saturated solution. The latter can be used all the time; the bichloride at shorter or longer intervals as shown by the effect.

The washing out can be done in one of two ways: first, on the siphon plan, in a manner similar to that employed for siphoning out the stomach, by elevating and lowering the funnel connected with the catheter by a long rubber tube. This method is preferable when the dilatation, and consequently the quantity of pus, are considerable. Second, the fluid can be injected with a small one- or two-ounce syringe. When the pus is too thick to flow, the injection of a watery fluid thins it and permits it to escape. If the kidney can be handled, manipulation will help to mix the pus with the fluid. If this is not done, the injected fluid may return without bringing the pus with it. Suction by means of the syringe may start the flow by clearing the catheter of clots which obstruct its lumen. After evacuating large accumulations from the kidney Kelly never injects more than two-thirds to three-fourths the amount taken out, to avoid renal colic. He has cured three cases by this treatment, and states that the improvement takes place in the following order: 1. The amount of pus diminishes; 2. The pus becomes thinner and more mixed with urine as the kidney begins to secrete; 3. The pus becomes scanty, the dilatation of the kidney diminishes and finally disappears, and cure takes place.

Thorkild Rovsing describes under the name of "psuedo-membranous pyelitis" an inflammation of the ureter accompanying nephrolithiasis, characterized by the passage of pseudo-membranous bodies of various sizes up to that of an olive-stone, grayish like boiled meat, round or olive-shaped masses arranged in concentric layers and containing a nucleus of gravel of urates. The author believes them to be coagula deposited around gravel and changed by the action of microbes in this peculiar manner. The microbes found in the author's two cases and in one reported by Lennander were the colon bacillus. These round and oval masses are found in great numbers, and occasionally occlude the ureter and give rise to attacks of renal colic. One of the patients refused operation, but in the other case he did a nephrectomy on the dilated suppurating kidney. The ureter was irrigated from the lumbar wound, bringing down into the bladder a great deal of pus and the masses described above. The upper end of the ureter was then closed by a ligature. In the course of the following two months similar bodies and pus appeared in the urine, and finally a stone 2½ cm. long, 1½ cm. broad, and 1 cm. thick was found in the vesical end of the ureter, and removed by suprapubic cystotomy. Perfect recovery followed.

TUBERCULOSIS OF THE URETER.

Tuberculosis of the ureter may be descending or ascending. The ureter may either be dilated or stenosed. In the dilated ureter local retractions alternating with dilatations may be found, and tuberculous ulcers on the mucosa in the dilated territories. The ureter is more commonly not dilated, but is the seat of diffuse tubercular infiltration of the entire wall, so that the ureter is felt as a hard solid or nodular cord. The tuberculous infiltration of the mucous membrane may produce caseous masses which may encroach upon or fill the lumen.

The ureter may be primarily obliterated, and no pus will be found in the urine. If the ureter is permeable, the kidney is not enlarged; while if the ureter is stenosed or obliterated, tuberculous cystonephrosis is found.

Tuffier saw a case of tuberculosis of the spine, the tuberculous abscess from which was in contact with the ureter. In this place the tuberculosis invaded the ureter, causing an ascending tuberculous ureteritis which obliterated the canal and extended to the kidney. In another case of tuberculosis he observed on one side a ureteritis obliterans extending the whole length of the canal with dilatation of the kidney of this side; on the other side there was a ureteritis with dilatation, alternating with stenosis and tuberculous ulcers.

Edward von Meyer reports a case from Czerny's clinic. The patient was a girl of eighteen with right pyonephrosis. Tubercle bacilli were not found, although she had a tuberculous history. She was kept a long while in the hospital in order to ascertain, if possible, the condition of the other kidney; this was obtained accidentally by the injection of Koch's tuberculin. The general reaction was not violent, but locally the sensation of pressure in the region of the right kidney increased. "In a few hours after the injection the patient passed perfectly clear urine free from pus, in considerable quantity, of normal specific gravity, and containing no albumin." This experiment was repeated several times, and always with the same result. The diagnosis was made of tuberculosis of the pelvis of the kidney and part of the ureter; the tuberculin injection caused swelling and occlusion of the ureter. Tubercle bacilli were now found in the urine, probably from "disintegration of the tubercles." Czerny performed nephrectomy and found a kidney with multiple cheesy abscesses, the ureter thickened and imbedded in cicatricial masses, so that its removal down to the pelvis minor was necessary.

N. Tirard reports a case of tubercular growth of the ureter in a boy of five who died from general tuberculosis. In the left ureter a hard nodule was found at the junction of the upper and middle thirds. The ureter was dilated above and constricted below. Force was required to pass a probe through this nodule. On slitting the ureter open, it was found to be studded with small tubercles, and at the place of the nodular swelling the wall was surrounded by a ragged mass which consisted of a caseous surface on which urates were deposited. There was no tuberculosis outside of the ureter either in the bladder or the kidney.

Howard Kelly reports the case of a woman of twenty-five who had chronic pyuria. The ureteral catheter showed clear urine from the right kidney. In the left ureter resistance was met some distance up, and no fluid passed after waiting ten minutes. He succeeded in manipulating the catheter through an obstruction, when a continuous stream of purulent alkaline urine containing tubercle bacilli was evacuated. Thus the diagnosis of tuberculosis of the left kidney and ureter was made, and the patient cured by nephro-ureterectomy.

TUMORS OF THE URETER.

Tumors of the ureter are rare, and consequently little is known about them. No primary tumor of the ureter is on record. A tumor from the kidney or its pelvis may extend down into the ureter, which has been seen in villous tumor of the pelvis. It has also been observed that a primary tumor of the pelvis may be implanted at a distance in the ureter in the shape of multiple polypi.

Ribbert reports the case of a four-year-old girl operated upon by Oscar

Witzel. The child had a tumor which filled the right half of the abdomen. No history. The tumor and the upper 2 cm. of the ureter were extirpated, but large retro-peritoneal tumors had to be left, and the patient died six days later. The autopsy showed a large right cystonephrotic sac, on which the flattened kidney lay. The cyst was consequently the dilated pelvis, the wall of which was transformed into a layer of tumor-tissue 3 cm. thick. On the inside of the sac, in addition to flat prominences in the thick portions, there were seen polypoid tumors, especially from the site of the kidney—one as large as the fist with a pedicle the size of a finger, a second tumor a little smaller with a broader base, and a considerable number of small, thin-pedicled polypi.

The right ureter, as shown at the autopsy and described by Ribbert, was enormously dilated, tortuous, and tense. The dilatation was caused by numerous polypi of different sizes originating from the mucous membrane. They occurred in groups in the somewhat thickened wall. They were from several millimeters to several centimeters long, and some were as "large as a catheter." The larger ones were thickened in the middle; the smaller ones had a thin pedicle terminating in a club-shaped end. Some of the polypi had no free end, but were reattached at a place where a second group of polypi originated. Three long and slim polypi originated 2 cm. above the vesical orifice of the ureter. The total number of polypi, not counting the very small ones, was twenty-two. The polypi were soft and mostly gelatinous and transparent, grayish-white in the thicker portions, with here and there hemorrhagic spots. The vesical opening of the ureter was normal. Upon microscopic examination the tumors were found to be strio-cellular myosarcomata.

In Rayer's *Atlas*, Plate XI. fig. iv., are shown a kidney and ureter. In the ureter two inches below the pelvis is a polypus 1 cm. long and $\frac{1}{2}$ cm. in diameter; in the pelvis are seen seven polypi about the same size and five smaller ones. The polypi were soft, spongy, and yellowish red.

A primary tumor of the bladder may extend to the vesical portion of the ureter, causing stenosis, as is so often found in malignant tumors in this region. A tumor may invade the ureter from without when located somewhere in its course, as was seen in J. H. Taggart's case of sarcoma of the ureter. Retroperitoneal sarcoma had invaded the right ureter after totally surrounding the ureter from the kidney to the brim of the pelvis. In this territory the sarcoma also entirely surrounded the aorta and vena cava, and invaded the latter with a sarcomatous thrombus. The whole lower part of the ureter was transformed into a large solid cord, the sarcoma having invaded the wall down to the bladder, into which the sarcomatous wall of the ureter projected as a polypoid tumor.

An special position, not strictly speaking among the tumors, is occupied by the psorospermial cysts which may be found in the ureter alone or in the renal pelvis and bladder also. Harrison states that obstruction from psorospermial cysts or mucous cysts of the ureter is very common in rabbits, but exceptional in man.

Rayer in his *Atlas*, Plate LII., has depicted two cases of what he terms "vesicular eruption" of the ureter, pelvis, and bladder, which undoubtedly are psorospermial cysts. They form multiple small globular, transparent protuberances, with the mucosa stretched over them, from the size of a pin to that of a buckshot. They may cause dilatation and obstruction, as in J. Jackson Clarke's case of psorospermial cysts of the left kidney and ureter and of the bladder, with hydronephrosis of the left kidney: A woman about sixty was admitted to St. Mary's Hospital, where she died soon afterward from cerebral apoplexy. In the dilated pelvis of the left kidney and the upper half of the ureter numerous cysts were seen of a greenish-brown color and of the size of a hempseed. There was moderate hydronephrosis. There were also numerous small cysts at the neck of the bladder and at the vesical orifice of the ureters. He found psorosperms in the cysts.

In F. S. Eve's case of psorospermial cysts of both ureters they were found together with hematuria, but there was probably no connection between them. The patient, a woman of fifty-one, complained of frequent micturition with hematuria. The urine later became alkaline and the patient anemic. Fever set in, and the patient died two weeks later. The ureters were the seat of the psorospermial cysts, some of which had ruptured and left round openings in the mucous membrane. The author did not know whether or not the psorospermial cysts were the cause of the hematuria.

FISTULÆ OF THE URETER.

Fistulæ of the ureter are either traumatic or spontaneous. A traumatic fistula is caused either by a complete rupture or a transverse wound, when retraction of the ends of the ureter renders re-establishment of the canal impossible. A spontaneous fistula may result from a perforation caused by a stone, by tuberculosis, or by cancer, but spontaneous fistulæ are comparatively rare.

Each fistula has two openings and a canal. The external opening is either cutaneous, when it is located on the skin either of the inguinal region or the anterior abdominal wall; or visceral, when it opens into the uterus, vagina, or intestinal tract.

The canal is usually shorter in the visceral and longer in the cutaneous fistulæ, and is often tortuous, with thick, indurated walls.

The internal or ureteral opening is frequently surrounded by a small cavity close to the divided ureter or the opening in the ureter above the stone or stricture.

The characteristic symptom is the flow of urine. The urine is either normal or contains pus if pyelitis exists or if a periureteral abscess-cavity is present. The flow of urine is continuous if the fistula is located in the upper portion of the ureter, but may be intermittent if located in the lower third and if the opening is small (Tuffier). The urine may remain clear, and infection may not take place for a long time in the cutaneous fistulæ, but if the ureter opens into an abscess or into the uterus, intestine, or vagina, infection will cause ascending ureteritis and nephritis, often accompanied by dilatation from stenosis in some part of the fistula. The stenosis and retention will cause intermittent attacks of fever and pain.

As to the **course** and **termination**: The fistula, unless caused by operation, is persistent throughout the patient's life. Often he may be in relatively good health for a long time, but ascending infection is always liable to supervene, and the flow of urine is a constant source of misery.

In making a **diagnosis** it must be determined whether the urine comes from the renal pelvis or ureter. In pelvic and renal fistulæ the urine is usually purulent, as it comes from a suppurating pelvis or kidney, while in ureteral fistulæ the kidney is often healthy, and the urine therefore normal.

To distinguish a ureteral from a vesico-vaginal or vesico-uterine fistula colored fluid may be injected into the bladder, or a sound may be passed through the fistula into the bladder, to be felt by a sound passed through the urethra.

Treatment.—It is difficult, and probably impossible, to cure ureteral fistula without operation. Possibly permanent catheterization of the ureter may be of advantage in a few cases, but as yet no cures have been recorded. Fistulæ above the vesical portion of the ureter have, as a rule, been cured only by nephrectomy; and, although this operation has given fairly satisfactory results, we should always seriously consider the possibility of saving the kidney by an attempt to re-establish the continuity of the ureter, either by uretero-ureterostomy or by operation for the stenosis of the ureter below the fistula. Persistence of a ureteral fistula is always due to occlusion or stricture of the distal or vesical portion of the canal. Thus we should attempt to determine the cause of the impermeability and overcome it by dilatation or operation. Nephrectomy of a useful kidney should be the operation of last resort.

Fistulæ in women in or near the vesical portion of the ureter—the uretero-uterine or uretero-vaginal fistulæ—have been treated by kolpokleisis or by implantation into the rectum, but should preferably be treated by implantation into the bladder.

The cure of the incontinence of urine caused by uretero-uterine and uretero-vaginal fistulæ is accomplished in four ways:

(*a*) Plastic operations with a view to displace the fistula from the vagina or cervix into the bladder;
(*b*) Kolpokleisis;
(*c*) Implantation of the ureter into the bladder;
(*d*) Nephrectomy, the operation of last resort.

(*a*) **Plastic Operations.**—Simon, through an artificial if not pre-existent vesico-vaginal fistula, opened the proximal end of the ureter from the bladder, cauterized the divided borders until cicatrization had taken place, thus securing against reclosure, and finally closed the vesico-vaginal fistula.

Landau passed a catheter into the ureter through a vesico-vaginal fistula, bringing the distal end of the catheter out through the urethra, and by immediately closing the vesico-vaginal fistula invaginated the ureteral opening into the bladder.

Bandl employed a combination of the methods of Simon and Landau.

Schede inverted the ureteral opening into the bladder, together with a zone of the surrounding vaginal mucous membrane, with the intention of preventing subsequent cicatricial stenosis.

Pozzi employed with advantage a method of splitting similar to that devised by Gerdy for vesico-vaginal fistula.

These plastic operations are often difficult in technique. Repeated attempts at closure have frequently to be made, and in some cases inflammation of the ureter and kidney has resulted. The operations on uretero-uterine and uretero-cervical fistulæ are especially difficult. The operations are taxing to the patience of the operator and patient, rather than dangerous to life. They have always been attempted before direct methods of obliteration were resorted to.

(*b*) **Kolpokleisis**, proposed by Vidal du Cassis and Simon, and first practised by Hahn, consists in closure of the vagina on the distal side of a vesico-vaginal fistula, and possesses the disadvantage that the latter may contract, and that marital relations are made impossible excepting in cases wherein partial kolpokleisis, as devised by Kaltenbach, can be done.

(*c*) **Implantation of the ureter into the bladder** for uretero-vaginal fistula was performed in 1893 by Novaro. In February, 1893, he operated successfully by the Paoli-Busachi method in the following case: The patient had had vaginal hysterectomy performed for carcinoma extending into the the broad ligament; the operation was followed by uretero-vaginal fistula. Two months later laparotomy in Trendelenburg's position was performed, the ureter dissected out from the vagina, divided for 1 cm., unfolded, and united by sutures to an incision in the bladder $1\frac{1}{2}$ cm. long, situated two finger-breadths above the normal point of insertion. Gauze drainage out through the abdominal wound. For several days the gauze was impregnated with urine, showing leakage at the point of union. This was only temporary, however, and ten days after the operation the function of the urinary organs became normal and remained so.

(*d*) **Nephrectomy,** the operation of last resort, really means the abandonment of the struggle with the fistula. It has been necessitated in some instances by infection of the kidney, and, although not very fatal, as in 14 cases on record only 1 patient died, it is applicable only to cases where the other kidney is healthy.

The operative results, as collected by Nebe in 1890 and Iversen in 1892, were as follows: Of 14 uretero-uterine and uretero-cervical fistulæ, all following childbirth, 8 were operated upon—1 with hysterokleisis (Duclont); 1 kolpokleisis (Hahn), both relatively successful. The remaining 6 cases (Zweifel, Credé, Fritsch, Netzel, Traub, and Iversen) were unsuccessful and nephrectomy had to be done. It will thus be seen that direct displacement of the ureter into the bladder was not found applicable to this class of cases.

Of uretero-vaginal fistulæ 32 cases were collected by Nebe, 5 by Iversen, 1 reported by Arie Geyl, 1 by Pozzi, and 1 by Hergott (cited by Pozzi)—a total of 40 cases, of which 10 were secondary to operations or pelvic abscesses, 28 followed childbirth, and in 2 cases the cause was unknown. Of these 40, 24 were operated upon as follows: Plastic invagination into the bladder through the vagina was successful in 10 cases (Bandl 2; Lannelongue, Geyl, Parvin, Schede, Solowjeff, Schauta, Pozzi, and Hergott); kolpokleisis was performed in 5 cases (Gusserow 2, Kehrer, Schede, and Kaltenbach, partial); and nephrectomy in 5 cases (Schede, Gusserow, Czerny, Heilbrunn, and Fritsch). In the remaining 4 cases attempts at operating were abandoned.

In the 10 cases which did not follow childbirth 5 followed vaginal hysterectomy, 3 pelvic abscess, and 2 operation on vesico-vaginal fistula. Two were cured by direct closure (Nicoladoni, Emmet); 3 by kolpokleisis (Kaltenbach 2, Hempel); in 3 nephrectomy was performed (Stark, Böckel, Bardenheuer, whose patient died). The remaining 2 cases, both following pelvic abscess (Emmet), were not operated upon.

It will thus be seen that in 34 cases of ureteral fistula this condition was remedied by plastic operation in 11 cases, by kolpokleisis in 7, hysterokleisis in 1, and nephrectomy in 15.

The perfect success of implantation of the ureter into the bladder in Novaro's case, as well as in cases of wounds of the lower end of the ureter, would seem to indicate that Paoli and Busachi may be right in proposing the application of this operation to uretero-uterine and uretero-vaginal fistulæ. If the operation is as safe and certain as the cases now on record indicate, and if the future function of the implanted ureter remains undisturbed, this method would seem to be superior to the older plastic operations through the vagina, which are difficult in technique, uncertain in results, and sometimes fail entirely.

Taking into consideration the fact that in almost all, if not in all, of the cases the kidney in question was healthy from the beginning, it seems to be a reproach against our present methods of treatment that in 44 per cent. of the cases the kidney should have been sacrificed.

URETERECTOMY.

Ureterectomy has been done for tuberculosis or suppuration of the ureter where there was retention or evacuation of infectious contents either into the bladder or through a persistent lumbar fistula.

Ureterectomy is termed primary when the ureter is removed simultaneously with the kidney; secondary when, after nephrectomy, the removal of the ureter of the same side becomes necessary.

Both primary and secondary nephrectomy may be either total or partial, and the operation may be performed by either the trans-peritoneal or extra-peritoneal method.

Primary total ureterectomy was twice performed by Kelly in 1895. Primary partial ureterectomy was performed in February, 1891, by Tuffier, who removed 4 cm. of the ureter with the kidney; by Kelly in March, 1893, for tuberculosis; by Postnikow in February, 1894, who termed the operation nephro-ureterectomy, and removed the kidney and the ureter down to 2 cm. above the bladder; and in 1896 by Elliot, who removed the kidney and the abdominal portion of the ureter.

Secondary ureterectomy is done when, after removal of the kidney, the fistula from the diseased ureter does not close or persistent discharge into the bladder takes place. Secondary total ureterectomy was first performed by Reynier, who did a nephrectomy in April, 1892, and an extirpation of the ureter seven months later. Secondary partial ureterectomy was made by Poncet, who extirpated a tubercular kidney in February, 1891, and about three years afterward extirpated 7–8 cm. of the ureter.

Primary Total Extra-peritoneal Nephro-ureterectomy.—CASE 1.—Kelly reports a left nephro-ureterectomy for tuberculosis of kidney and ureter in a woman of twenty-three who had suffered from childhood from incontinence of urine. She had had intermittent pain in the bladder for six years, and pain in the left kidney and pyuria for a year. Cystoscopic examination and catheterization showed the right kidney to be normal; the bladder normal, except the left ureter, which was found to furnish the pus and to be stenosed, probably from tuberculosis. Kelly determined, therefore, to extirpate the kidney, together with the entire ureter, and eventually to resect the diseased portion of the bladder-wall around the ureteral opening. The kidney and ureter down to the bladder were removed by an extra-peritoneal operation in December, 1895, in the following manner: An oblique lumbar incision was made from the vertical muscles of the back down to an inch above the symphysis pubis. The tuberculous kidney was enucleated after clamping and tying the renal vessels, but was left connected with the ureter during the dissection of the latter. This dissection was continued down to the pelvic brim, the ureter being freed with the fingers and pulled downward with the attached kidney. The lumbar portion of the wound was closed over a gauze drain before the dissection of the pelvic portion of the ureter was made. Through the lower part of the incision the round ligament was exposed and the deep epigastric vessels divided between ligatures. The peritoneum was loosened from the external iliac vessels, and the ureter dissected out down to the base of the broad ligament. The uterine vessels were here ligated by passing sutures around them, and divided where they cross the ureter, so as to expose the latter, which could then be loosened up to its intravesical portion at a point 5 cm. below the vaginal vault. The contents of the ureter were squeezed up toward the kidney and the ureter clamped 2 cm. above the bladder, and a ligature put around it close to the latter. The ureter was divided close to the clamp, and the kidney, with its ureter 23 cm. long, lifted out. The vesical end of the ureter was sterilized with crude carbolic acid and dropped to the pelvic floor, whence a gauze drain was brought out through the lower end of the wound. The patient made an uninterrupted recovery.

Case 2.—Kelly performed a similar operation on a woman of thirty with tuberculosis of the right kidney and ureter, with remittent attacks of colic and retention. Vaginal examination showed the ureter as a hard, tender cord 1 cm. in diameter. Cystoscopic examination showed that the left kidney and ureter were normal, the bladder normal with the exception of a red mammillated area around the right ureteral orifice, from which purulent urine was taken with the ureteral catheter. No tubercle bacilli were found in the urine.

In 1895 an oblique incision 16 cm. long was made from the posterior vertical muscles to the outer border of the right rectus muscle. The kidney was loosened, found to be the seat of extensive tuberculosis in its middle portion, and removed after first clamping the renal vessels and ligating them separately. At this moment the renal vein slipped out of the forceps, but was speedily caught and a ligature put around it by means of a needle. The kidney, still connected with the ureter, was pulled out of the wound, thus making the ureter tense while the peritoneum was stripped off with the fingers down to the common iliac artery. From here the ureter in the small pelvis was isolated by introducing the whole hand in the wound to strip off the peritoneum from the small pelvis and ureter down to the broad ligament. At this point the ureter broke off, and was caught by a forceps and isolated for 2 cm. more. The ureter was then ligated just behind the broad ligament and cut off above the ligature. The lower portion of the ureter was caught through an incision in the vaginal vault and drawn down into the vagina, and held there while the abdominal wound was closed with a gauze drain inserted in its middle. The patient was then placed in the lithotomy position and the lower end of the ureter extirpated through the vagina. During this dissection the friable ureter broke off twice, but was caught again, and finally cut off close to its entrance into the bladder-wall. The vaginal wound was left open and packed with iodoform gauze. Recovery was uneventful.

Primary Partial Extra-peritoneal Ureterectomy.—Tuffier reports the case of a married woman, thirty years of age, who had suffered for six years from symptoms of right pyelitis with intermittent cystonephrosis. The left kidney was healthy. On February 22, 1891, he operated immediately after one of the periodical evacuations. Through a lumbar incision he came down upon the dilated kidney half full of liquid. In attempting to make a subcapsular nephrectomy the thin-walled sac was ruptured and discharged its purulent contents; it consequently became necessary to remove the capsule with the kidney. During the isolation of the sac he exposed the abdominal portion of the ureter. This was the size of a pen-holder, and presented a sigmoid bend 4 cm. below the hilus of the kidney. When pressure was made upon the sac before rupture, the fluid would pass down and distend the ureter as far as the lower curve of the bend. Upon increased pressure the bend would straighten and the fluid would pass through. This manipulation demonstrated the cause of the intermittence of the cystonephrosis. The isolation was difficult because the partially filled, thin-walled sac was adherent to its surroundings. After isolation down to the ureter the pedicle was clamped with a curved forceps and the sac cut off. He thus gained space to ligate the vessels. The ureter was then ligated immediately below the sigmoid bend and the upper portion removed.

The operation, which had lasted for an hour, was followed by considerable shock and complete anuria for more than twenty-four hours. The patient recovered without fistula, and regained her health with the exception of a slight cystitis.

Trans-peritoneal Primary Partial Nephro-ureterectomy.—On March 30, 1893, Kelly performed this operation for tuberculosis of the left kidney and ureter. The patient, who had been a stout and healthy girl, had become worn out and emaciated from tuberculosis of the left kidney and ureter, which caused frequent and extremely painful spasms of the bladder. Vaginal examination showed a thickening of the left ureter, which was felt as a tender nodular cord 1 cm. in diameter, and could be palpated up to the brim of the pelvis, and above this point could be traced by abdominal palpation as a well-marked line of tenderness. Catheterization of the ureters showed that the right ureter and kidney were normal. The catheter in the left ureter passed through a stricture, whereupon 90 c.cm. of purulent alkaline urine containing tubercle bacilli were evacuated.

An incision was made through the left side of the abdomen parallel to the outer border of the rectus muscle. The viscera were displaced to the right, and the posterior peritoneum cut through on the outer side of the colon, which was drawn to the right to expose the ureter on the psoas muscle. The ureter was traced up to the cystic kidney, which was enucleated with difficulty on account of fibrous tissue which surrounded the hilus. After ligature of the vessels and removal of the kidney the large hard ureter was dissected from above downward to the pelvic brim. At about the middle of its course the ovarian vessels were tied. After freeing the ureter from the common iliac vessels its further detachment became so difficult that it had to be tied and cut off 4 cm. below the pelvic brim on the floor of the pelvis. The abdominal portion and upper half of the pelvic portion of the ureter were thus removed. The mucosa of the ureter above the ligature was sterilized with the thermo-cautery and the wall sutured. From the bed of the ureter an opening was made outward through the lumbar region for drainage with a strip of gauze. The opening in the posterior peritoneum was not united, as the borders lay in apposition. The abdominal wound was closed without drainage. The lumbar drain was removed on the fifth day, and both wounds healed by primary union. The urine became clear and the patient made an excellent recovery. About six weeks later Kelly attempted to remove the lower end of the ureter by a vaginal incision, but found it impossible, as it was surrounded by dense cicatricial tissue which bled profusely when incised. Three years later the patient was in excellent health, with but one of her old discomforts remaining—namely, frequency of micturition.

Primary Partial Trans-peritoneal Nephro-ureterectomy.—P. J. Postnikow, in a case of left hydronephrosis in a woman of fifty-five, on February 18, 1892, found by median laparotomy a dilated ureter connected with the hydronephrotic sac. The hydronephrotic kidney was opened and stones found in the lower portion of the ureter. Thirteen stones were pushed up and removed through the wound, leaving a large one which could not be caught. The ureter was isolated down below the stone, and the kidney and ureter down to 2 cm. above the bladder removed. A lumbar opening was made and a strip of iodoform gauze inserted down to the ligated lower end of the ureter, the peritoneum closed by sutures over the ureter, and the abdomen closed. The patient had severe shock and vomiting for four days. After this she improved rapidly, was out of bed in fourteen days, and two months afterward was in perfect health.

Primary Partial Extra-peritoneal Nephro-ureterectomy.—J. W. Elliot reports the case of a woman of twenty-four who had a right nephrotomy in 1895 for suppuration. Wound closed in twenty-six days. On account of recurrent pain the wound was reopened and a urinary fistula remained. The amount of urea in the urine from the fistula was on an average 48 grains in twenty-four hours. On April 17 he removed the right kidney by extra-peritoneal operation. The ureter was found to be dilated to the size "of a man's thumb;" the walls were thick and rigid. This ureteritis, with dilatation, extended to the brim of the pelvis. The ureter was extirpated down to this point, and the upper end of the pelvic portion closed by inversion and sutures. The specimen showed "uretero-pyelonephritis; this was probably caused by a stone which had disappeared." The wound healed without fistula, and seven months later the patient was in perfect health.

Secondary Total Extra-peritoneal Ureterectomy.—Paul Reynier had a patient, a man with pyonephrosis following typhoid fever. Lumbar incision April 27, 1892, revealed the "kidney transformed into a purulent cyst" and the ureter dilated to size of intestine. The kidney was extirpated and the ureter sutured to lower angle of wound. Suppuration in the dilated ureter continued, so as to cause a flow of pus partly through the lumbar fistula and partly through the ureter into the bladder as seen by the cystoscope. The suppuration continued in spite of irrigation of ureter from the lumbar wound. Two or three months later a second operation was performed, consisting of dilatation of the lumbar wound and isolation of the ureter up to the "superior strait of the pelvis." The ureter was pulled out as far as possible and a ligature applied, and the ureter divided low down. During this maneuver the ureter ruptured and retracted into the small pelvis, and the operator was unable to find it. Thinking the ureter had been ruptured close to the bladder, he did a third operation eight days later, and tried to find it through a pararectal incision, as devised by Roux for extirpation of the seminal vesicles, but was unsuccessful, as two months later pus was still seen to enter the bladder through the ureteral orifice. A fourth operation was done for the total extirpation of the lower end of the ureter on November 14, as follows:

The bladder was distended with boric-acid solution; Peterson's balloon inserted in the rectum; an extra-peritoneal incision was made above and parallel to Poupart's ligament; the peritoneum was loosened from the iliac fossa, and blunt dissection made along the vas deferens till the iliac vessels were exposed, on top of which the ureter was found adherent to the peritoneum, its upper end obliterated, enlarged to the size of an intestine until just above the bladder, where the caliber became normal. The length of the dilated portion of the ureter was 12 cm. After having isolated it and scraped the mucous membrane with the sharp curette in its intravesical portion, he applied a ligature close to the bladder and extirpated the ureter above. The patient made a speedy and lasting recovery.

The author believes this to be the first total extirpation of the ureter, and concludes that in a certain number of cases it is not sufficient merely to remove the kidney and leave a dilated suppurating ureter, as persistent fistulæ have been seen to follow nephrectomy, most commonly in tuberculosis, but also in non-tuberculous cases. He attributes the complaints of pain in the side so often stated to follow nephrectomy to the leaving of the ureter. In the author's case these pains persisted until the whole of the ureter was removed, and in cases of this kind a subsequent total ureterectomy is the only means of effecting a cure.

As to the method of operating, the author lays stress upon the inguinal incision and the route along the vas deferens as a guide to find the lower portion of the ureter in the small pelvis, either at the superior strait or lower down, where the vas deferens crosses the vessels. Peterson's balloon in the rectum will push up the bladder and make the vesical portion easier of access. This incision gives better access than the iliac incision of Twynam, and, being extra-peritoneal, is preferable to the pararectal route, which does not give free access to the ureter.

Secondary Partial Extra-peritoneal Ureterectomy.—Poncet reports the case of a woman of twenty-eight with tuberculosis of right kidney and ureter. On November 5, 1890, right nephrotomy was performed. On February 28, 1891, the right kidney was extirpated. The patient was well, with the exception of a small fistula, for two years. Then she had pain in the course of the ureter and frequent micturition. In April, 1893, deep curettement of the fistula was done. On October 18, 1893, on account of the persistence of the fistula and pyuria, ureterectomy was performed. An incision was made from the fistula toward the anterior superior spine of the ilium, 1½ cm. from it, and prolonged 5 or 6 cm. below. After division of the wall the peritoneum was pushed aside. Small openings were twice made in the peritoneum and sutured. When the iliac vessels were reached two small lymph-glands, which were at first taken to be the ureter, were removed. It was difficult to find the ureter, and the peritoneum was opened repeatedly. Finally, the ureter was found as a hard cord in the peritoneum which had been pushed aside. The ureter was now isolated upward and downward with great difficulty on account of adhesions. When the neighborhood of the bladder was reached the ureter was caught by a hemostatic forceps, cut off above, isolated upward, removing a cord 7 or 8 cm. in length. It was obliterated in the upper portion for 1 cm. The large opening into the peritoneum was drained with iodoform gauze. The wound healed and the patient recovered after a catheterization cystitis. (This operation was probably not a total extirpation of the ureter, as the portion removed was only 7–8 cm. in length, and was probably not removed below the posterior surface of the broad ligament.)

Tuffier has studied the remote results of nephrectomy. A permanent fistula following nephrectomy is a rare complication. In 12 cases of Tuffier's there was no fistula, and in 73 operations collected from the literature there were 25 per cent. of definite fistulæ, but it was not stated whether the operation was performed for tuberculosis or renal calculus. In reality, however, there is often prolonged although not abundant suppuration. Thus, suppuration continued in one of Tuffier's patients for ten months after lumbar nephrectomy. In 7 per cent. of the cases he has found temporary fistulæ. The cause of the fistula is either perirenal sclerosis or ureteritis. The perirenal sclerosis forms a septic cavity with unyielding walls like an empyema. Such a patient is operated on too late. The ureteritis should be treated by scraping the wall (?). It is only the ureteritis with dilatation—that is, with retention of pus—that is capable of causing a fistula; but even in this case if there is sufficient drainage into the bladder a cure may take place (but the suppuration goes on and pus enters the bladder all the time).

If it is desired to extirpate the entire ureter with the kidney, Tuffier proposes the following procedure: Make a lumbar linear incision, commencing at the angle of the twelfth rib and the sacro-lumbar muscle, down to the crest of the ilium, and then parallel to it, along it, and then down along Poupart's ligament to the upper orifice of the inguinal canal. Cut off the kidney, ligate the ureter, pull it out, and enucleate progressively from above down to the bladder. This is an exceptional operation to be employed in cases of obliterations of the ureter only, and, as permanent fistulæ are infrequent, it will be rarely indicated.

H. A. Kelly details the operation of nephro-uretereetomy as follows (see Figs. 186, 187, 188): Oblique lumbar incision from the sacro-lumbar portion of the erector spinæ downward and forward 2 cm. anterior to the anterior superior spine of the ilium, and then obliquely downward to the terminal of the semilunar line 2 cm. above the symphysis pubis. The perirenal fat is loosened from the kidney, and the latter brought out of the incision, drawing it down over the lower lip of the incision to expose the renal vessels, pelvis, and ureter. The kidney and pelvis are now examined to determine whether nephrectomy or a conservative operation is to be done. When tuberculosis is found nephrectomy is done. The vessels are clamped by artery-forceps 1 cm. from the kidney, after freeing them from the surrounding fat. The vessels are then ligated separately if possible.

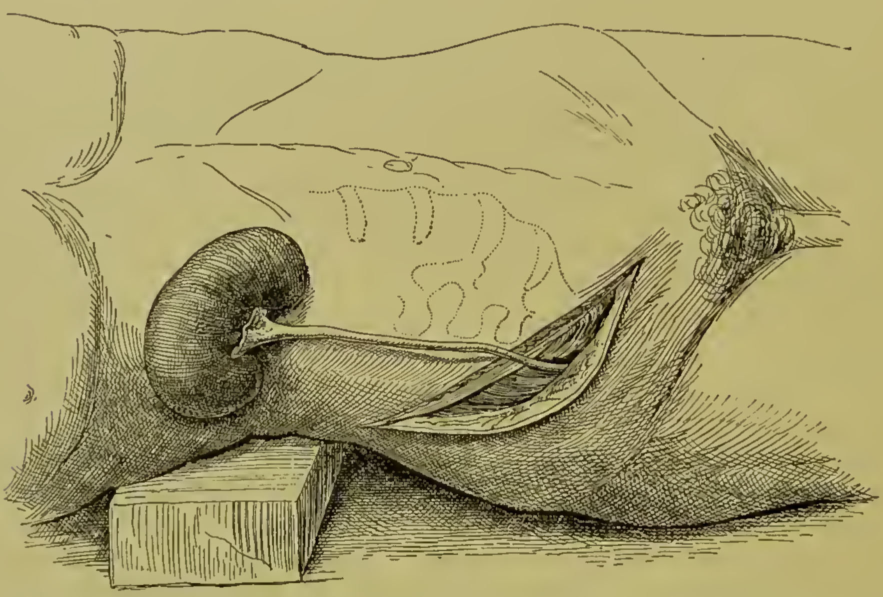

FIG. 186.—Extra-peritoneal nephro-ureterectomy Cadaver with kidney detached and entire ureter separated down to its vesical extremity through the incision shown in the cut, without opening the peritoneum at any point (Kelly).

If the ureter is found to be diseased, the kidney and entire ureter are now removed in the following manner: By pulling on the kidney and ureter the latter is made tense and dissected out from the surrounding loose connective tissue, with the index and middle fingers pushing the colon and cecum to one side and stripping off the loose connective tissue surrounding the ureter. This dissection is carried down to the brim of the pelvis, where the common iliac artery is felt. To free the ureter from this point down to the vaginal portion the entire hand is passed into the wound, at first between the peritoneum and the abdominal wall, then under the peritoneum of the pelvis major, and finally between the peritoneum and the walls of the pelvis minor.

This blunt dissection is facilitated by pulling on the kidney and making the ureter tense. In this way the ureter is freed and followed to the broad ligament, where considerable resistance may be felt, and the ureter appears to pass through an opening in the ligament, above which the pulsations of the uterine artery can be felt. At this point, about 6 cm. from the kidney, the abdominal end of the ureter is caught in forceps and held, and a stout silk ligature put around it and tied securely just behind the broad ligament. By pushing and working with the finger about 2 cm. more of the ureter is freed. The ureter is now cut off $\frac{1}{2}$ cm. above the ligature with a long pair of scissors introduced through the lumbar incision, guided by the hand introduced into the pelvis in the same way. Before cutting through the ureter the operator should take care to squeeze back its contents and keep the upper end tightly compressed until it is removed.

The next step is the removal of the lower end of the ureter. This is done either through a continuation of the original incision or through the vagina. The vagina is thoroughly disinfected, and with the patient lying on the opposite side, two fingers of the hand corresponding to the ureter to be removed are passed up to the vaginal vault, and the other hand introduced into the pelvis through the abdominal incision. The fingers of both hands can now be brought together with only vaginal tissue between them. An opening is made in the vaginal vault, the end of the ureter brought down into the vagina, clamped in a pair of forceps until the lumbar wound is closed, after which the vaginal end of the ureter is removed.

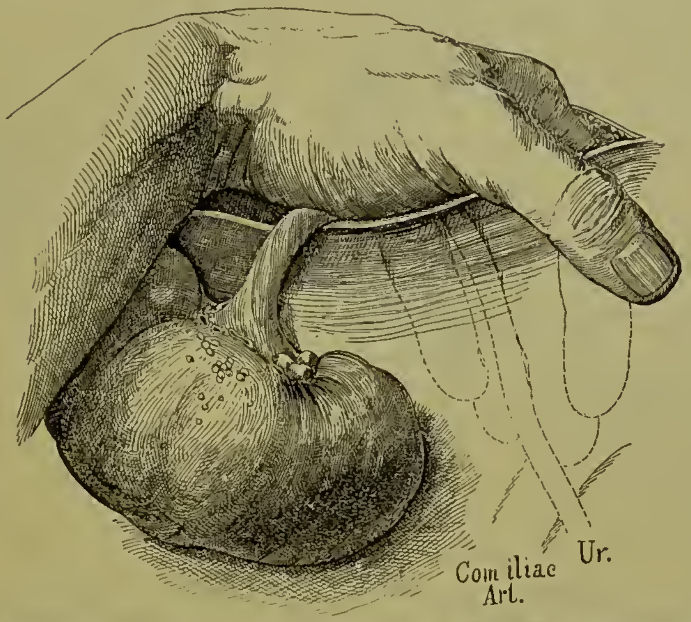

Fig. 187.—Renal vessels divided and ureter freed down to the brim of the pelvis. The object of this picture is to show the ease with which the entire abdominal portion of the ureter can be palpated through a horizontal incision, with only a part of the hand introduced (Kelly).

The steps in this operation are as follows: The opening in the vaginal vault is made by passing the entire hand through the lumbar wound, down into the pelvis and pressing the index and middle fingers against the vaginal fornix, at the same time lifting up the uterine artery on the index finger, so as to avoid the danger of cutting it. The end of the ureter lies between these fingers. The index and middle fingers of the other hand are now introduced into the vagina and pressed up against the fingers of the hand in the abdomen, the palmar surfaces of both hands being turned upward.

The opening in the vault necessary to draw the end of the ureter into the vagina is now made by an assistant, who introduces a pair of sharp-pointed scissors up to the vaginal vault along the fingers of the operator, and, guided by him, pushes the scissors through the thin septum. By spreading the blades of the scissors in withdrawing them the opening in the vault is enlarged to about 2 cm. This opening is located about 2 cm. to the side of the cervix. A pair of forceps is pushed through the opening to grasp the ligature attached to the ureter, and the ureter is drawn through into the vagina and held there during the closure of the lumbar incision. This is done in the usual manner, after thorough cleansing of the wound, by separate suturing of the muscles and fascia, and a gauze drain placed through the wound.

If the patient's condition permit, the last step in the operation—namely, the extirpation of the vesical end of the ureter—is now proceeded with.

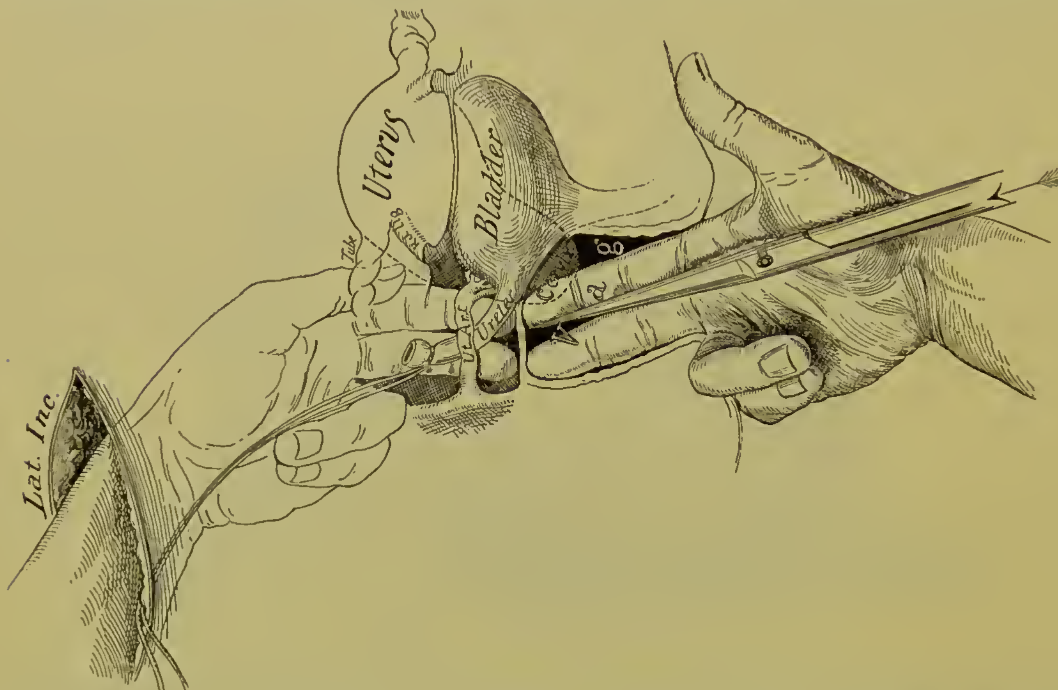

FIG. 188.—Opening the vaginal vault to bring the extremity of the right ureter through. The patient lies in the left semi-prone posture, and the left hand is carried through the lumbar incision behind the peritoneum down to the right vaginal fornix; the uterine artery is held up on the index finger. The right hand is introduced through the vagina to the vault. The assistant then pushes the scissors through the vault, guided by the operator (Kelly).

The patient is put in the lithotomy position, the end of the ureter and the opening in the vault exposed by retractors, and the corresponding side of the cervix caught by a bullet-forceps and drawn to the opposite side. By pulling on the forceps holding the ureter this is made tense while the operator cuts down through the vaginal vault, at first at the side between the anterior and lateral walls, and then, curving the incision forward under the base of the bladder, to a point $1\frac{1}{2}$ cm. from the vesical end of the ureter. The ureter should now be freed down to its vesical extremity, and here ligated and cut off. The wound in the vaginal vault is then closed by sutures, leaving space for a gauze drain, which is pushed up through the vault into the extensive connective-tissue space above, and left hanging down in the vagina.

That this operation is difficult it is needless to state. The wound is extensive, the freeing of the ureter in the pelvis minor has to be done guided by touch and not aided by vision, and the ureter, especially when extensively diseased, is liable to break and cause trouble in finding the broken ends. In fact, the ureter broke off three times in one of Kelly's operations, and also in the operation of Reynier.

The three cases whose histories Kelly gives exhibit three different ways of removing the kidney with its ureter:

"First, trans-peritoneal—that is, through an incision through the abdominal wall opening the peritoneal cavity; this incision involves the necessity of a second incision through the peritoneum, covering the posterior abdominal and pelvic walls in order to get at the ureter.

"Second, retro-peritoneal—the extirpation of the kidney and ureter through a long abdominal incision beginning in the loin and extending downward and forward, and ending somewhere in the neighborhood of the symphysis pubis. By this method the peritoneum is detached from its cellular connection with the abdominal and pelvic walls, lifted up, and the ureter exposed without opening the peritoneal cavity.

"Third, retro-peritoneal—by a short abdominal and a vaginal incision; by this procedure the kidney is detached and the ureter freed from all its connections through a short incision in the loin as far forward as the base of the broad ligament. The rest of the ureter is then pulled through an opening made in the vault of the vagina, and removed down to its vesical end by continuing the vaginal incision forward toward the neck of the bladder."

IMPLANTATION OF THE URETER.

1. **Implantation of the Ureter into the Bladder.**—When the upper end of the divided ureter is long enough to reach the bladder, implantation into this organ is preferable to all other procedures, as the danger of subsequent infection of the ureter and kidney is thereby avoided.

The experiments of Paoli and Busachi in 1888 upon dogs were successful. Their method consisted in splitting the distal end of the ureter and uniting it by sutures to an incision in the bladder.

The successful implantation of the ureter into the bladder by Novaro, Krug, Penrose, Baumm, and others leads us to believe it possible in these cases to save the kidney, which would otherwise be sacrificed.

The congenital abnormal opening of the end of the ureter outside of the bladder, in the urethra or the vagina, causing partial incontinence of urine, is naturally treated in the same way as uretero-vaginal fistulæ, either by vaginal, suprapubic, or trans-peritoneal implantation into the bladder.

(*a*) **Extra-peritoneal implantation of the ureter into the bladder** has been made by Baumm and Westermark.

Baumm's patient had a double ureter on the right side, one ending at the mouth of the urethra and causing partial incontinence of urine. Baumm performed a suprapubic operation, cut an opening through the bottom of the bladder, and connected it with the proximal end of the accessory ureter, the distal end of which was ligated. The author himself does not recommend this operation, which he chose because the patient was a virgin, as he considers it under ordinary circumstances unnecessarily severe. He considers the operation through the vagina preferable.

Westermark reports the case of a woman forty-two years old with carcinoma of the uterus, which he extirpated by the sacral method. The carcinoma had invaded the lower portion of the left ureter and the neighboring portion of the bladder. He then extirpated the lower end of the ureter and a portion of the bladder-wall 4 cm. in diameter. The wound in the bladder was united and the ureter implanted in the corner of the bladder-wound. Fine catgut sutures were applied through the muscularis of the bladder, not including the mucosa and the muscular layer of the wall of the ureter. By means of four such sutures the outer surface of the bladder-wall was folded over the ureter, making it pass obliquely into the bladder. Over this a new row of sutures was placed, folding in, over an additional piece of the ureter a little higher up, an additional layer of bladder-wall, on the principle of Witzel's operation for gastrostomy. The ureter healed without any leakage of urine. Six months later the patient was in perfect health.

(*b*) **Intra-peritoneal Implantation of the Ureter into the Bladder.**—In February, 1893, Novaro operated successfully by the Paoli-Busachi method in a case of vaginal hysterectomy, followed by uretero-vaginal fistula, which has been reported above in the section on Fistulæ.

In the two following cases of implantation into the bladder the operators acted upon Van Hook's suggestion of uretero-uretorostomy, and the effect of the operation in each case was complete, as undoubtedly no leakage of urine took place:

Krug reports the case of a colored woman, about thirty years of age, who had suffered from a fibroid for over six years. During most of this time she had been subjected to electrical treatment. When he saw her on the morning of the operation he found her very much emaciated, with a poor pulse. The tumor filled the entire pelvis and extended above the umbilicus. On opening the abdomen universal adhesions were found. After having removed the greater part of the omentum he commenced by tying off the tube and ovary on the left side. The next ligature was placed around the round ligament and the excess of broad ligament on that side. Although he expected to meet with some difficulty in shelling out the tumor, which was entirely intra-ligamentous, and therefore paid particular attention to the ureter, he found that in cutting off the round ligament he had cut the left ureter in front of the tumor. The tumor had evidently grown intra-ligamentous, unfolding the two sheets of the broad ligament, lifting up the ureter, and the injury was done at a place where he felt absolutely secure. Putting clamp-forceps on the proximal and distal ends respectively, he finished the operation, which was an extremely difficult one. Finding then that he could reach the bladder without putting too much tension on the proximal end of the ureter, he decided to graft the ureter into the bladder. An incision being made into the bladder, the ureter was treated in a manner similar to that employed by Van Hook in invaginating the cut ends of the ureter. In sewing up the incision in the bladder care was taken to prevent leakage without constricting the lumen of the ureter. Several tiers of running sutures were made, and all available peritoneum used to build up a solid wall around the ureter. A permanent catheter was introduced into the bladder, which remained for four days. For two more days the patient was catheterized every four hours. A normal amount of urine was passed immediately after the operation. There was no rise of temperature nor any other untoward symptom. The patient left the hospital about four weeks after the operation; at last report she was doing hard work and feeling splendidly.

Penrose reports a case of a woman forty years of age with scirrhous carcinoma of the cervix uteri involving the left broad ligament and about 2 cm. of the ureter. He performed abdominal hysterectomy in July, 1893. The left ureter passed through a hard mass in the left broad ligament: 2 cm. of the ureter were excised and the distal end ligated with silk. The peritoneum was sutured over the seat of operation, and the proximal end of the ureter implanted into the bladder after Van Hook's method. The vagina was closed. The abdomen was closed without drainage. No disturbance of bladder or kidney followed. The patient left the hospital twenty days after the operation and made a good recovery.

In a case of vaginal hysterectomy for fibroma, followed by uretero-vaginal fistula, Bazy performed laparotomy, and found the lower portion of the dilated ureter, which was buried and compressed in cicatricial tissue. The ureter was aspirated, loosened, and implanted into the bladder. The operator placed a permanent catheter in the bladder and one in the ureter for five days. Cystoscopic examination one month later showed the ureteral opening in the bladder to be patent, and that a pre-existent dilatation of the kidney had disappeared. Bazy termed this operation "uretero-cysto-neostomy."

The perfect success of the operation in these cases would seem to indicate that Paoli and Busachi may be right in proposing the application of this operation to uretero-uterine and uretero-vaginal fistulæ. If this operation is as safe and certain as the above cases indicate, and if the future function of the implanted ureter remains undisturbed, this method would seem to be superior to the older plastic operations through the vagina, which are difficult in technique, uncertain in results, and sometimes fail entirely.

(*c*) **Vaginal implantation**, as probably the safest method, was chosen by Davenport in the following case: Woman, twenty-nine years. Incontinence of urine from early childhood, due to malposition of the ureter. Incontinence increased by menstruation and pregnancy. One ureter was found in the vesico-vaginal septum, running forward, its orifice being close to the external orifice of the urethra. Operation for displacement of its orifice into the bladder; recovery.

2. **Implantation of the Ureter into the Bowel.**—Implantation into the small intestine, colon, and rectum has been studied experimentally by Rosenberg, Novaro, Morestin, Tuffier, Gluck and Zellar, Harvey Reed, Van Hook, and others.

Morestin made experimental bilateral implantation of the ureter in the rectum on 10 dogs, all of whom died—6 from peritonitis and ascending renal infection, 2 from infection, and 2 from compression of the ureter. He also made unilateral implantation of the ureter in the rectum on 14 dogs, most of whom died. He concludes that implantation of the ureter into the rectum is a grave operation, and that bilateral implantation is to be rejected.

Tuffier in the discussion of Morestin's paper stated that the absence of the ureteral sphincter facilitates ascending infection. If the vesical orifice of the ureter be implanted, it is better, but there is still liability to ascending infection.

Boari, after successful experiments on this point in dogs with a bobbin, refers to two cases in the human subject in which the method was successfully applied. The ureter is fastened round one end of the bobbin, which is then introduced into the bowel through a small longitudinal incision, which is afterward sewn up. In process of time union occurs and the bobbin is passed *per anum*. The drawings which illustrate the paper make the method easy to be understood.

In the first case (tuberculosis of the bladder) the button was passed *per anum* on the eighth day, and round its neck was seen the silk which had been fastened round its end to affix the ureter. The first urine was noticed sixteen to twenty-four hours after the operation, and henceforth, at intervals of two to three hours, about 200–300 c.cm. In the second case (large vesico-vaginal fistula with total destruction of the urethra) the button came away *per anum* on the twelfth day. In both cases Boari reports that the results were satisfactory.

The technical difficulties of implantation of the ureter into the bowel have been fairly well overcome, but there seems to be a serious objection to this plan of implantation on account of the liability to infection of the ureter and kidney by intestinal microbes, and also because of some tendency to constriction at the place of implantation. Van Hook found both these conditions present in dogs as early as ten days after the operation. Reed found acute nephritis in one dog killed twenty-four days after the operation, but in another similar case the kidney was apparently healthy.

In man the implantation suggested by Roux was tried unsuccessfully by Simon, but successfully, according to Rosenberg, by Chaput in two cases.

In a case of uretero-vaginal fistula following vaginal extirpation of the uterus Chaput implanted the ureter into the colon. He performed laparotomy, divided the peritoneum on the posterior wall, isolated the ureter, divided it transversely, and fixed its renal end into the colon by a double row of step sutures. The vesical end of the ureter was ligated. The patient recovered and was well satisfied with her condition. She was obliged to void mixed urine and feces three or four times a day. Five months after the operation there were no signs of infection of the kidney.

Van Hook condemns the operation very strongly on account of the liability to infection; and he is undoubtedly right. The bowel, therefore, should never be chosen when it is possible to implant the ureter into the bladder. If this be impossible on account of defect in the ureter, it is still an open question whether or not implantation into the colon should be tried before resorting to implantation on the skin in the lumbar region or abdominal wall, or nephrectomy.

Maydl has proposed and executed an original and ingenious way of implanting both ureters with an island of the surrounding bladder-wall into the sigmoid flexure as a cure for exstrophy of the bladder. He thinks it possible that when the ureteral sphincter in the vesical wall is preserved ascending infection may be avoided; and the results thus far obtained seem to justify his expectations.

He performed the operation in the case of a girl of twenty-two, who had exstrophy of the bladder, with a double left and a single right ureter. He made an incision around the bladder so as to loosen it from the abdominal wall, beginning at the umbilical end, and at this point opening into the peritoneal cavity. He next excised from the lower portion of the bladder an oval island containing all three ureteral openings, the margin of the island being 1½ cm. outside of the ureteral openings, care being taken not to open into the ureters. The ureters were now carefully dissected out after sounds had been introduced through the ureteral openings. The dissection was made guided partly by the sounds and partly by the fingers introduced into the peritoneal cavity from above. The island with the ureters was now freed from its surroundings, care being taken not to divide the vessels in connection with the ureters. The remainder of the bladder-wall was extirpated. The sigmoid flexure was then drawn out of the wound, emptied, compressed above and below, and a longitudinal incision made in its convex surface for implantation of the island with the ureters. This was accomplished first by a row of mucosa sutures, and this again covered by muscularis and serosa sutures. The bowel was then replaced in the abdomen and an iodoform-gauze drain passed down to the place of implantation. The abdominal wall was united by step sutures down to the drain, and a permanent drainage-tube inserted in the rectum. The patient left the hospital in eighty-four days. One year later she was in excellent health; rectal micturition took place every six or eight hours. The patient was able to do her work as a servant and showed no symptoms of infection of the kidneys.

In another case, a girl of seven, there was rectal micturition only five or six times in the twenty-four hours.

Maydl has operated on 5 cases: 1 died in twelve hours, probably from protracted narcosis. He believes that the danger of infection is less in the sigmoid flexure than if implantation is made in the ileum, where the processes of decomposition are more active.

The contraindications for this operation are pre-existing nephritis or pyelitis.

3. **Implantation of One Ureter into its Fellow.**—Monari divided the ureter close to the bladder in dogs, closed the vesical end with a silk suture, isolated the renal end sufficiently to permit it to pass through an incision in the mesentery of the sigmoid flexure, and united it with the ureter of the opposite side (Fig. 189). Union followed, and when the dog was killed four months later a constriction was found at the place where the ureter passed through the opening in the mesentery, with consequent dilatation of the ureter above and of the pelvis, but at the place of anastomosis with the other ureter there was no narrowing of the lumen. He proposes to use this method on man in cases of abnormal exit of the ureter, in preference to implanting it in the bladder.

Implantation in the bladder is probably preferable to the method proposed by Monari, because it is easier of performance.

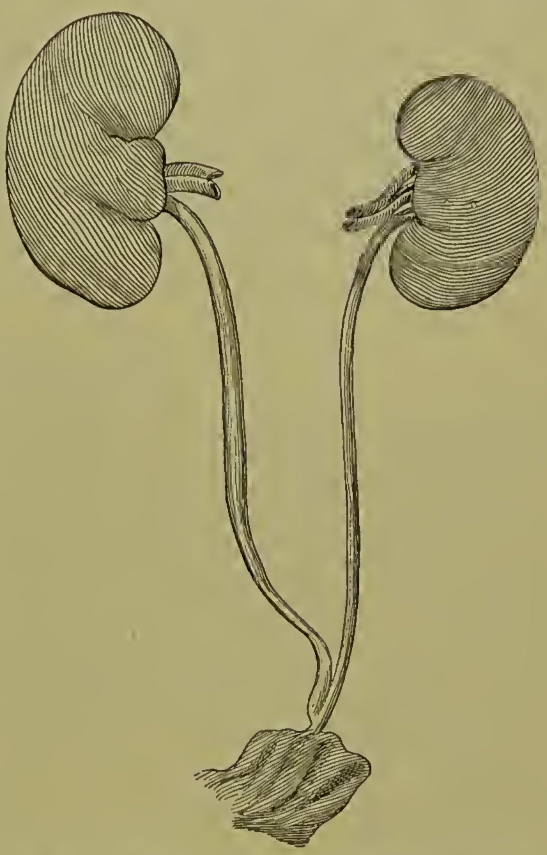

Fig. 189.—Monari's operation of implantation of one ureter into its fellow.

4. **Implantation of the Ureter on the Skin.**—Le Dentu was the first to implant the ureter on the skin for anuria in a case of absolute impermeability from cancer in the small pelvis. The symptoms were relieved, but the patient died thirteen days later from cancerous cachexia. This case, however, established the operation as an effective procedure to be employed in combating anuria due to incurable mechanical causes, as it at least prolonged life.

Pozzi, in the removal of a retro-peritoneal parovarian cyst by laparotomy, divided the ureter at about its middle. The upper end was dissected out for 4 or 6 cm. and implanted into the skin in the lumbar region through a button-hole opening. The distal portion of the ureter was sutured to the lower end of the abdominal wound. The patient recovered from the operation, and three months later nephrectomy was resorted to, which was followed by recovery. Microscopical examination of the kidney showed that it was healthy, with the exception of a few small islands of interstitial nephritis. No septic invasion had taken place, as no micro-organisms were found. The integrity of the kidney in this case, after so long a period of exposure through the open ureter, is remarkable, and, according to Albarran, was due to the antiseptic precautions in the after-treatment. This case was one in which uretero-ureterostomy might have been performed with advantage.

Losses of substance of the ureter too extensive to permit of uretero-ureterostomy, or located too high up to permit of implantation of the upper end into the bladder, will require either implantation on the skin or into the bowel. As both of these methods are objectionable on account of the liability to infection sooner or later, and the consequent necessity of nephrectomy, operative procedures to effect a connection with the bladder have been proposed by Rydygier and Van Hook based upon dissections on the cadaver.

Rydygier proposes to implant the two ends of the ureter on the abdominal wall, and by plastic operation to make a channel of skin between them to make good the loss of substance of the ureter.

Van Hook proposes by plastic operation on the bladder to create a diverticulum long enough to meet the upper end of the ureter.

In both of these methods it is proposed to place these newly-formed channels in the abdominal wall. Theoretically, these methods appear feasible, but they have not as yet been practised on animals or on the human subject.

BIBLIOGRAPHY.

ALBARRAN, G., and LLURIA, H.: "Cathétérisme permanent des uretéres," *Comptes-rendus de la Société de Biologie*, vol. iii., 1891, No. 24, p. 543, and No. 26, p. 587.

ALLINGHAM, HERBERT W.: "A case of presumed rupture of the ureter from external violence; laparotomy; cure," *British Medical Journal*, Mar. 28, 1891, p. 699.

ALSBERG: "Resection eines Harnleiters mit Krankenvorstellung. Discussion," *Verhandlungen der Deutschen Gesellschaft für Chirurgie*, XXI. Congres, 1892, p. 43.

BAKER, W. H.: "Malpositions of the Ureters," *New York Medical Journal*, Dec., 1878, p. 575.

BANDL: *Wiener medizinische Wochenschrift*, Nos. 30 and 32, 1877.

BAUMM: "Operirter Fall von 3 Ureteren bei einem erwachsenen Mädchen," *Centralblatt für Gynäkologie*, No. 17, 1892, p. 336.

BAZY: "De l'uretéro-cystonéostomie," *Annales des Maladies des Organes génito-urinaires*, vol. ii., 1893, p. 938.

BERG, J.: *Hygeia*, vol. li., 1889, No. 7, p. 144.

BLOODGOOD, J. C.: "Anastomosis of the right ureter in a dog," *Annals of Surgery*, vol. xix., 1894, p. 76.

BOARI, A.: "Manière facile et rapide d'aboucher les uretéres sur l'intestin sans sutures à l'aide d'un bouton spécial," *Annales des Maladies des Organes génito-urinaires*, vol. xiv., 1896, p. 1.

BOCCHINI: "Nuovo processo operativo del Prof. Novaro per la cura della fistola uretero-vaginale," *Riforma Medica*, Mar. 23, 1893.

BOIS (D'AURILLAC): "Anomalie de l'uretére chez la femme," *Bulletins et Mémoires de la Société de Chirurgie de Paris*, vol. xix. p. 371.

BOSTROM: *Beiträge zur pathologischen Anatomie der Nieren*, vol. i., Freiburg, 1884.

BOVEE, J. WESLEY: "Uretero-ureteral anastomosis," *Annals of Surgery*, Jan., 1897, p. 51.

BRAUN, H.: "Ueber Nierenextirpation," *Deutsche medicinische Wochenschrift*, No. 32, 1881, p. 437.

BRENNER: "Katalog vom Instrumentenmacher Leiter," Wien, 1887, p. 8.

BROWN, J.: "Catheterization of the male ureters," *Johns Hopkins Hospital Bulletin*, Sept., 1893, p. 73.

——: "Catheterization of the ureters in the male," *Ibid.*, vol. vi., 1895, p. 12.

Cabot, A. T.: "Another successful case of uretero-lithotomy," *Boston Medical and Surgical Journal*, Dec. 25, 1890, p. 613.

——: "Observations upon the anatomy and surgery of the ureter," *American Journal of the Medical Sciences*, Jan., 1892, p. 43.

Casper, L.: "Der Katheterismus der Ureteren," *Deutsche medicinische Wochenschrift*, No. 7, 1895, p. 104.

Ceci: *La Riforma Medica*, Sept. 5, 1887.

Chaput: "Fistule urctéro-vaginale guérie par l'abouchement de l'uretére dans le côlon iliaque; Guérison," *Bulletins et Mémoires de la Société de Chirurgie de Paris*, vol. xix., 1893, p. 309.

Clarke, J. Jackson: "A case of psorospermial cysts of the left kidney and ureter, and of the bladder, with hydronephrosis of the left kidney," *Pathological Transactions*, vol. xliii., 1892, p. 94.

Colzi, F.: "Contributo allo studio delle anomalie di sbocco degli ureteri," *Esperimentale*, anno 49, Sezione Biologica, fasc. 1.

Crampton, Sir P.: "A case of aneurysm of the external iliac artery in which a ligature was applied to the common iliac artery," *Medico-Chirurgical Transactions*, vol. xvi., 1830, p. 162.

Cullingworth, C. J.: "Impaction of a large calculus in each ureter immediately above the vesical orifice, causing dilatation of the ureters and abscesses in the kidneys," *Pathological Transactions*, vol. xxxvi., 1885, p. 278.

Czerny: cited from H. Braun.

Davenport, F. H.: "Incontinence of urine due to malposition of the ureter," *Boston Medical and Surgical Journal*, Oct. 30, 1890, p. 420.

Delbet: "D'une opération qui permet de découvrir la dernière portion de l'uretére," *Annales des Maladies des Organes génito-urinaires*, 1891, p. 746.

Ebermann: cited by König-Maas, *Lehrbuch der Chirurgie*, 3 Auflage, Berlin, 1881.

Elliot, J. W.: "Nephro-ureterectomy; retroperitoneal extirpation of a kidney with its ureter," *Boston Medical and Surgical Journal*, Feb. 25, 1897, p. 173.

Emmet, B. McE.: "Injured ureters in abdominal surgery," *American Journal of Obstetrics*, Apr., 1895, p. 449.

—— T. A.: cited by Hunter, *Medical Record*, Apr. 7, 1883, p. 386.

—— T. A.: *Principles and Practice of Gynæcology*, 1884.

Eve, F. S.: "A case of psorospermial cysts of both ureters," *Pathological Transactions*, vol. xl., 1889, p. 444.

Fenger, Christian: "An operation for valvular stricture of the ureter," *American Journal of the Medical Sciences*, Dec., 1896, p. 667.

——: "Conservative operative treatment of sacculated kidney—cystonephrosis," *Annals of Surgery*, June, 1896, p. 637.

——: "Demonstration of specimens from operations on the kidney," *Chicago Medical Recorder*, Mar., 1893, p. 155.

——: "Operations for the relief of valve-formation and stricture of the ureter in hydro- and pyonephrosis," *Journal American Medical Association*, Mar. 10, 1894, p. 335.

——: "Surgery of the ureter," *Annals of Surgery*, Sept., 1894, p. 257.

Gaither, A. B.: "Catheterization of the ureters in the male," *Journal of Cutaneous and Genito-urinary Diseases*, Dec., 1894, p. 491.

Geyl, Arie: "Zur Therapie der Ureterfisteln," *Volkmann's Sammlung klinischer Vorträge*, No. 37 (*Gynäkologie*, No. 14), 1892, p. 311.

Glantenay, L.: *Chirurgie de l' Uretére*, Paris, 1895.

Glass: *Philosophical Transactions*, vol. xliv., cited by Rayer.

Gluck: cited from Nitze.

Guyon: cited by Albarran and Lluria.

——: "Exploration uretérale," cited from Tuffier, "Appareil urinaire," p. 520.

Hahn, E.: "Bericht über einzelne bemerkenswerthe Urinfisteln beim Weibe," *Berliner klinische Wochenschrift*, No. 27, 1879, p. 397.

Hall, R. B.: "Report of a case of extirpation of a calculus from the ureter by the combined abdominal-lumbar section," *Medical Record*, Oct. 18, 1890, p. 430.

Halle, N.: "Les maladies chirurgicales de l'uretére; son exploration," *Gazette des Hôpitaux*, No. 112, 1887, p. 925,

——: "Uretérites et pyélites," *Thèse de Paris*, 1887.

Harrison, Reginald: "A study on the dead subject relative to catheterism of the ureters and exploration of the male bladder," *Lancet*, Feb. 2, 1884, p. 198.

——: "Diseases of the kidneys and ureters," *Twentieth Century Medicine*, vol. i. pp. 193, 194.

Hegar: cited by Sänger.

Henle, J.: *Handbuch der Eingeweidlehre des Menschen*, Braunschweig, 1873, p. 335.

Hyrtl: cited from *Henle's Handbuch der systematischen Anatomie.*

Iversen, A.: "Beitrag zur Katheterization der Ureteren bei dem Männe," *Centralblatt für Chirurgie*, No. 16, 1888, p. 281.

——: "Ueber Ureterfisteln," *Nordiskt Medicinskt Arkiv*, vol. xxiv., 1892, No. 22.

Kaltenbach: cited by Iversen, "Ueber Ureterfisteln."

Keen, W. W.: "Five cases of suprapubic cystotomy . . . . one for exploration with catheterism of the ureters," *Medical News*, Apr. 18, 1891, p. 431.

Kelly, H. A.: "Catheterization of the ureters," *Annals of Gynæcology and Pædiatry*, Aug., 1893, p. 641.

——: "Direct examination of the female bladder with elevated pelvis. The catheterization of the ureters under direct inspection with and without elevation of the pelvis," *American Journal of Obstetrics*, Jan., 1894, p. 1.

——: "Kolpo-ureterotomy. Incision of the ureter through the vagina for the treatment of ureteral stricture," *Johns Hopkins Hospital Bulletin*, vol. ii., 1890–91, p. 235.

——: "My recent ureteral work," *Annals of Gynæcology and Pædiatry*, May, 1893, p. 449.

——: "Nephro-ureterectomy," *Johns Hopkins Hospital Bulletin*, Feb.-Mar., 1896, p. 31.

——: "Some recent important advances in the diagnosis and treatment of urinary diseases in women," *Pittsburgh Medical Review*, Jan., 1896, p. 1.

——: "The ureteral catheter," *American Journal of Obstetrics*, June, 1892, p. 768.

——: "Ureteral anastomosis; uretero-ureterostomy," *Johns Hopkins Hospital Bulletin*, Oct., 1892.

Kirkham, F. W.: "A case of suppression of urine treated by removal of an impacted calculus from the ureter by operation," *Lancet*, Mar. 16, 1889, p. 525.

Krakauer, A.: "Hydronephrosis, *Dissertation*, Berlin, 1881," *Virchow-Hirsch Jahresbericht*, vol. ii., Abtheilung 1, p. 207.

Krug, Florian: Personal communication.

Kuster, Th.: "Ein Fall von Resection des Ureters," *Archiv für klinische Chirurgie*, vol. xliv. Heft 4, 1892, p. 850.

Landau, L.: "Ueber Entstehung, Erkenntniss und Behandlung der Harnleiterscheidenfisteln," *Archiv für Gynäkologie*, vol. ix., Heft 3, 1876, p. 426.

——: "Ueber intermittirende Hydronephrose," *Berliner klinische Wochenschrift*, Nos. 47 and 48, 1888.

Lane, W. Arbuthnot: "Calculus impacted in the ureter for twenty years; removal; recovery," *Lancet*, Nov. 8, 1890, p. 967.

Le Dentu, A.: *Affections chirurgicales des Reins, des Uretéres et des Capsules surrénales*, Paris, 1889.

——: "Greffe de l'uretére entre les lèvres d'un incision du flanc, chez une femme atteinte d'anurie absolue," *Congrès français de Chirurgie*, 1889, p. 533.

Lennander: "Om Njursten med tva lyckligt opererade Fall," *Upsala-Läkareförenings Forhandlingar*, Nov., 1896.

Lohnstein: "Ueber die neueren Methoden der Urethroskopie," *Berliner klinische Wochenschrift*, No. 46, 1894, p. 1054.

Luschka: *Die Anatomie des Menschen*, vol. ii., Abtheilung 1, Tübingen, 1863.

Mann, M. D.: "Inflammation of the ureters in the female," *Gynecological Transactions*, 1894, p. 224.

Margarucci, O.: "Ricerche sulla circolazione propria del' uretere," *Policlinico*, vol. xv., July, 1894, p. 321.

Maydl: "Neue Beobachtungen von Ureterimplantation in die Flexura romana bei Ectopia Vesicæ," *Wiener medizinische Wochenschrift*, Nos. 28, 30, and 31, 1896.

V. Meyer, Edward: "Ein Beitrag zur Verwendung des Koch'schen Tuberkulins als diagnostischen Hülfsmittels," *Deutsche medicinische Wochenschrift*, No. 9, 1893, p. 200.

Monari, U.: "Ueber Ureter-anastomosen. Experimentelle Untersuchungen," *Bruns' Beiträge zur klinischen Chirurgie*, vol. xv., Heft 3, 1896, p. 720.

Morestin, N.: "Greffe de l'uretére dans le rectum," *Mercredi médical*, Dec. 28, 1892, p. 622.

Morison, R.: "Two cases of ureterotomy for removal of calculi," *Lancet*, Nov. 10, 1894, p. 1093.

Morris, H.: "A case of congenital dilatation of both ureters, right ureterotomy and left nephrotomy in a new-born child; remarks," *Lancet*, vol. i., 1895, p. 1435.

Mynter, Herman: "Case of acute intermittent hydronephrosis from valvular stricture of the ureter," *Annals of Surgery*, Dec., 1893, p. 658.

Newman, D.: "Instruments for catheterization and compression of the female ureters; a method of inspecting the female bladder by means of the electric light," *Glasgow Medical Journal*, July, 1885, p. 52.

Nitze, Max: "Ueber kystopische Diagnostik chirurgischer Nierenerkrankungen mit besonderer Berücksichtigung des Harnleiter-katheterismus," *Berliner klinische Wochenschrift*, Nos. 16 and 17, 1895.

Novaro: published by Bocchini.

Orthmann, G. G.: "Zur Kasuistik der überzähligen Harnleiter," *Centralblatt für Gynäkologie*, No. 7, 1893, p. 137.

Otis, W. K.: "Aëro-urethroscopy," *Journal American Medical Association*, Aug. 24, 1895, p. 319.

Page, Herbert W.: "On traumatic ruptures of the ureter, with report of a case of ruptured ureter followed by nephrectomy in a child," *Annals of Surgery*, May, 1894, p. 513.

Paoli and Busachi: "La greffe des uretéres dans un point anormal de la vessie," *Annales des Maladies des Organes génito-urinaires*, 1888, p. 553.

Pawlik, C.: "Ueber die Harnleitersondirung," *Archiv für klinische Chirurgie*, vol. xxxiii., 1886, p. 717.

Penrose, C. B.: "A case of abdominal hysterectomy in which the ureter was resected and implanted into the bladder," *Medical News*, vol. lxiv., 1894, p. 470.

Perez: "Exploration des uretéres," *Thèse de Paris*, No. 302.

Poggi: "Guérison immédiate des sections transversales des uretéres sans oblitération de leur cavité," *Riforma Medica*, Nos. 53 and 54, 1887.

Poirier, P.: "Anatomie et physiologie des uretéres," *Annales des Maladies des Organes génito-urinaires*, 1891, p. 745.

——: "Cathétérisme permanent des uretéres. Dérivation du cours de l'urine," *Comptes-rendus de la Société de Biologie*, vol. iii., 1891, p. 570.

Poncet: "Uretérectomie totale pour uretérite obliterante, sclereuse, tuberculeuse, après ablation du rein droit remontant à 2 ans ½—Guérison"; cited by Glantenay.

Postnikow, P. J.: "Hydroureter cum Hydronephrosi. Nephrourectomia," *Archiv für klinische Chirurgie*, vol. xlix. Heft 3, 1895, p. 675.

Pozzi, S.: "Des blessures de l'uretére au cours de la laparotomie," *Annales des Maladies des Organes génito-urinaires*, 1891, p. 538.

——: "Uretero-vaginal fistula," *Medical and Surgical Gynæcology*, vol. ii. p. 328.

Pye-Smith, P. H.: "Stricture of the ureter and dilatation of the kidney, apparently of traumatic origin," *Pathological Transactions*, vol. xxiii., 1871–72, p. 159.

Ralfe, C. H., and Godlee, R. J.: "A case of suppression of urine caused by impaction of calculi in both ureters, relieved by operation," *Clinical Society of London's Transactions*, vol. xxii., 1889, p. 155.

Rayer's Atlas: Plate 52; Plate 11, Figure 4.

Rayer, P.: *Traité des Maladies des reins*, Paris, 1839.

Reed, R. Harvey: "Experimental research on the implantation of the ureters into the rectum," *Annals of Surgery*, Sept., 1892, p. 193.

Reichel, P.: "Ueber hernienartigen Vorfall eines Ureters durch den Leistenkanal," *Verhandlungen der Deutschen Gesellschaft für Chirurgie*, XXI. Congres, 1892, ii. p. 68.

Reynier, Paul: "Néphrectomie combinée avec l'uretérectomie totale," *Annales des Maladies des Organes génito-urinaires*, vol. xi., 1893, p. 233.

Ribbert: "Ueber ein Myosarcoma striocellulare des Nierenbeckens und des Ureters," *Virchow's Archiv*, vol. cvi., 1886, p. 282.

Rosenberg, S.: "Experimentelle Harnblasenplastik," *Virchow's Archiv*, vol. cxxxii., Heft 1, p. 158.

Rovsing, Thorkild: *Om Blaerebetaendelsernes Aetiologi, Pathogenese og Behandling*, Copenhagen, 1889.

——: "Pseudomembranös Pyelitis," *Hospitalstidende*, Nos. 10 and 11, 1897, pp. 213 and 237.

Rydygier, L.: "Ein Vorschlag zur Uretroplastik," *Oesterreich-Ungarisches Centralblatt für medizinische Wissenschaft*, No. 5, 1892, p. 76.

Sands: cited from P. Müller's "Ueber künstlichen zeitweiligen Harnleiterverschluss," *Deutsche medicinische Wochenschrift*, No. 31, 1887, p. 689.

Sanger, M.: "Ueber Tästung der Harnleiter beim Weibe," *Archiv für Gynäkologie*, vol. xxviii., 1886, p. 54.

Schede, M.: "Die operative Behandlung der Harnleiterscheidenfistel," *Centralblatt für Gynäkologie*, No. 23, 1881, p. 484.

Schopf, F.: *Centralblatt für Gynäkologie*, No. 30, 1887.

Schwarz, Carl: "Ueber abnorme Ausmündungen der Ureteren und deren chirurgische Behandlung (Nebst Bemerkungen über die doppelte Harnblase)," *Bruns' Beiträge zur klinischen Chirurgie*, vol. xv. Heft 1, 1895, p. 159.

Secheyron, L.: "Les abouchements anormaux de l'uretére dans le vagin à la vulve. Étude anatomique et clinique sur l'incontinence d'urine congénitale et considérations d'embryogénie sur une variété peu connue d'anomalie uretérale," *Archives de Tocologie*, 1889, pp. 254 and 335.

Segond, P.: *Traité chirurgicale de l'Exstrophie de la Vessie*, 1890, G. Chamerot.

Silbermann, O.: "Ueber eine neue Methode der temporären Harnleiterverschliessung und ihre diagnostische Verwerthung für die Krankheiten des uropoëtischen Systems," *Berliner klinische Wochenschrift*, No. 39, 1883, p. 518.

Simon: *Chirurgie der Nieren*, vol. ii., Stuttgart, 1876.

——: *Wiener medizinische Wochenschrift*, No. 28, 1876.

Sinitzin: cited by Poirier.

Sollier, T.: "Observation des reins cystiques," *Lyon médical*, No. 35, 1880.

Tait, Lawson: cited from Nitze.

Tanquary, W. W.: cited by Van Hook.

Targett, J. H.: "Sarcoma of the Ureter," *Pathological Transactions*, vol. xliii., 1892, p. 92.

Tauffer, W.: "Beiträge zur Chirurgie der Ureteren und der Niere," *Archiv für Gynäkologie*, vol. xlvii., 1894, p. 531.

Thornton: cited from Nitze.

Tillaux: cited by Poirier.

Tirard, N.: "Tubercular growths of the ureter," *Pathological Transactions*, vol. xliii., 1892, p. 91.

Tourneur: "De l'uretérite et de la périuretérite," *Thèse de Paris*, 1886.

Trendelenburg, F.: "Ueber Blasenscheidenfisteloperationen und über Beckenhochlagerung bei Operationen in der Bauchhöhle," *Volkmann's Sammlung klinische Vorträge*, No. 355, 1890, p. 3378.

Tuchmann: "Ueber künstlichen Verschluss einer Harnleitermündung," *Deutsche Zeitschrift für Chirurgie*, vol. v. p. 62.

——: *Die Diagnose der Blasen- und Nierenkrankheiten mittelst der Harnleiter Pincette*, Berlin, 1887.

Tuffier, Th.: "Appareil urinaire reins—uretéres—vessie—capsules surrénales," *Duplay et Reclus' Traité de Chirurgie*, vol. vii., Paris, 1892.

——: "Des résultats éloignés de la chirurgie rénale," *Annales des Maladies des Organes génito-urinaires*, vol. xi. p. 370.

——: *Études experimentales sur la Chirurgie du Rein*, Paris, 1889, p. 165.

——: "Résultats éloignés de la néphrorrhaphie pour rein mobile," *Congrès français de Chirurgie*, 1891, p. 377.

Twynam, George E.: "A case of calculus impacted in the ureter; removal," *Clinical Society of London's Transactions*, vol. xxiii., 1890, p. 93.

Ultzmann, R.: "Die Krankheiten der Harnblase," *Deutsche Chirurgie*, Lieferung 52, p. 290.

Van Hook, Weller: "Experimental union of the ureter after transverse division," *Journal American Medical Association*, Mar. 4, 1893, p. 225.

——: "The surgery of the ureters: a clinical, literary, and experimental research," *Ibid.*, Dec. 16 and 23, 1893, pp. 916 and 965.

Vaughan: "A case of hydronephrosis from obstruction of the ureter; nephrotomy; prolonged drainage of the kidney," *Journal of Cutaneous and Genito-urinary Diseases*, 1894, p. 537.

Virchow, R.: *Die krankhaften Geschwülste*, vol. i., Berlin, 1863.

Visconti, A.: *Atti della Associazione Medica Lombarda*, No. 5, 1892, p. 250.

Weil, J.: "Ein Fall von isolirter Harnleiter-scheidenfistel, bewirkt durch einen Mayer'schen Ring," *Wiener klinische Wochenschrift*, No. 16, 1892, p. 235.

Weir, R. F.: "Compression of the ureter," *Medical Record*, Apr. 7, 1884, p. 385.

Westermark: "Ein Fall von Implantation des Ureters in der Blase," *Centralblatt für Gynäkologie*, No. 7, 1895, p. 184.

Wiegert, C.: "Ueber einige Bildungsfehler der Ureteren," *Virchow's Archiv*, vol. lxx. p. 498.

Witzel, O.: "Beiträge zur Chirurgie der Bauchorgane," *Deutsche Zeitschrift für Chirurgie*, vol. xxiv. Heft 3 and 4, p. 337.

THE SURGICAL DISEASES OF THE KIDNEY.

By P. R. BOLTON, M. D.

The kidneys are deeply placed in the abdomen, lying in contact with its posterior wall, behind the peritoneum, and extend from the eleventh rib downward and slightly outward to the level of the third lumbar vertebra or almost to the iliac crests. The upper end of the right kidney is a trifle lower than the left, but, as its long axis is shorter than the left, the lower ends of the two organs lie in about the same horizontal plane.

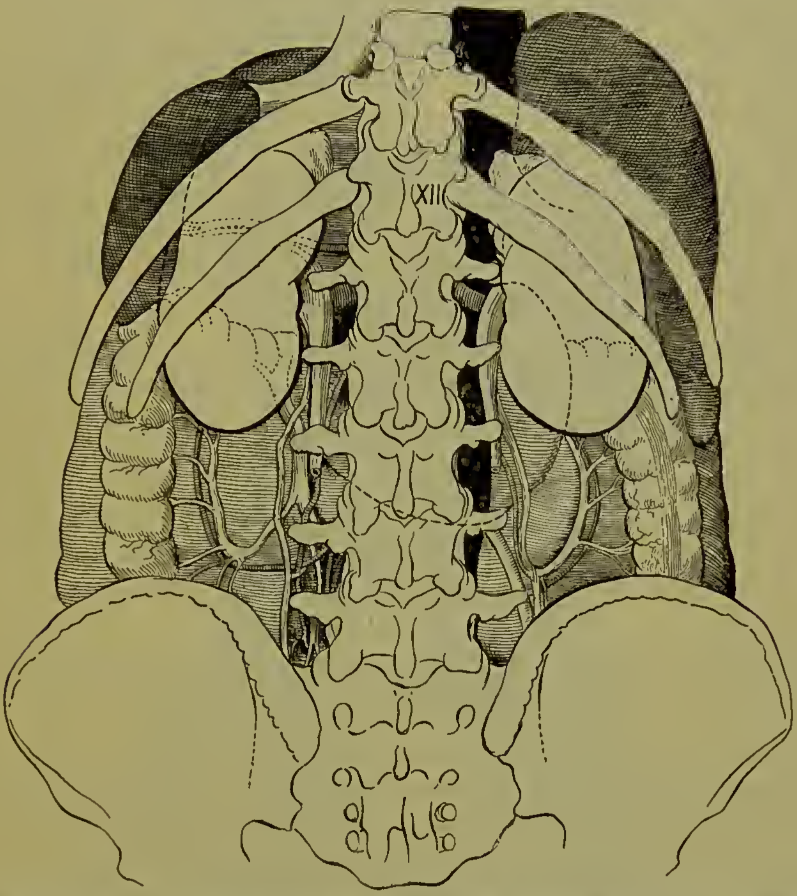

Fig. 190.—Relation of the kidneys as viewed through the lumbar wall. The two dark-shaded parts indicate the liver to the right, the spleen on the left; in front of the vertebral column the black tint represents the vena cava; the twelfth rib is long (after Farabeuf).

The posterior surfaces of the kidneys do not look directly backward, but rather backward and inward, and are in relation in each side with the diaphragm above, separating the kidney from the eleventh and twelfth ribs, and below with the anterior layer of the transversalis fascia, which is interposed between the kidney and the quadratus lumborum muscle, and supports the ilio-inguinal and ilio-hypogastric nerves and lumbar vessels.

In front the right kidney lies in relation with the right lobe of the liver, with the second part of the duodenum, and with the ascending colon, while in front of the left kidney are the stomach, tail of the pancreas, and descending colon, with the spleen applied to its outer border. The internal border of each kidney corresponds to the outer margin of the psoas muscle, and in the case of the right is close to the ascending vena cava.

Each kidney is enveloped by a quantity of fat, the fatty capsule, which, together with the structures entering the hilus, the renal artery and vein, and the ureter, serves to maintain the organ in its place. Traced upon the anterior abdominal wall, the upper end of the kidney with its surprarenal capsule is found in the epigastric region; the lower end lies behind the line erected from the middle of Poupart's ligament to the cartilage of the eighth rib at the level of the umbilicus, while the middle portion is behind the junction of the hypochondriac, epigastric, umbilical, and lumbar regions.

In the back the upper end of the kidney corresponds to the eleventh rib, and its lower end to the third lumbar vertebra, while its internal border is about 7½ cm. from the median line in the adult.

Thus the kidney may with propriety be regarded as situated within the thorax to the extent of almost its upper half, and its relations to the diaphragm and pleura are of no inconsiderable importance. Lange's[1] investigation of the anatomy of this region proves that in not a few instances the development of the twelfth rib is imperfect, and that when such is the case—and indeed occasionally when this rib is of normal length—the posterior border of the diaphragm, the ligamentum arcuatum externum, may be found below the level of the rib; and, as this structure marks the line of reduplicature of the pleura, this membrane may readily be wounded through incisions made in the loin.

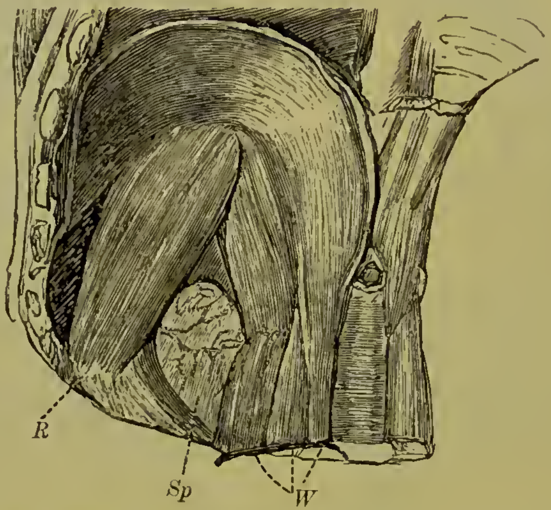

FIG. 191.—Muscle-fissure (*Sp*) between the origin of the diaphragm at the spinal column (*W*) and on the ribs (*R*) (Tillmanns).

In other instances the posterior fibers of the diaphragm may be rudimentary or even absent, when the fatty capsule of the kidney will be found lying in direct contact with the pleura.

The normal mobility of the kidney is of interest in connection with the subject of so-called movable and floating kidneys, and has been found to be considerable by experiments upon the dead body and observations upon the living organ exposed during operation.

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[1] *Annals of Surg.*, 1885, i. p. 286.

The movement imparted to the kidney by the descent of the diaphragm is not alone one in the vertical direction, but is also slightly outward; but for practical purposes the movement downward is alone to be considered, and this amounts normally to less than one inch.

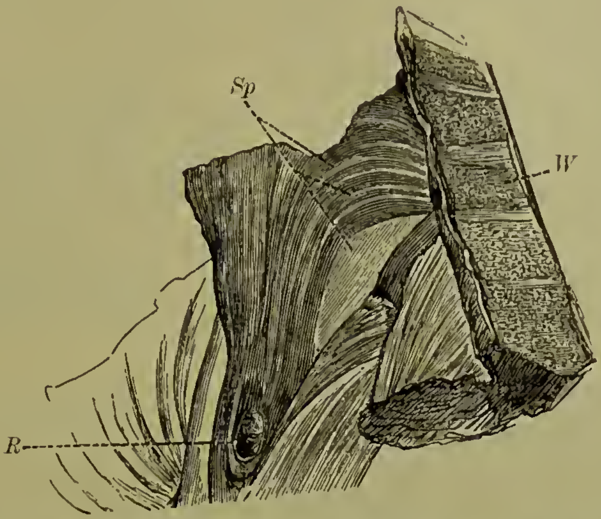

FIG. 192.—Muscle-fissure (*Sp*) between the origin of the diaphragm at the spinal column (*W*) and on the ribs (*R*) (Tillmanns).

ABNORMALITIES.

Malposition of the kidney, while rare and usually of only anatomical interest—for the functions of the displaced organ are generally performed in a perfectly normal manner—becomes important in the consideration of the diagnosis of abdominal tumors.

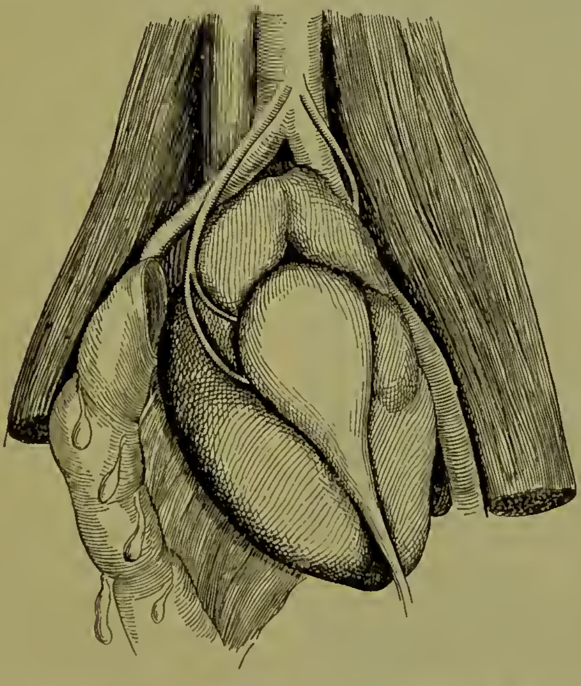

FIG. 193.—Representing the lobulated appearance of the kidney and its relations to the aorta and sigmoid flexure of the colon. Misplaced and malformed left kidney; misplaced sigmoid flexure of colon (Canton).

The misplaced kidney too may be the site of any of the diseases peculiar to this gland, and may therefore demand surgical treatment; or the kidney in its abnormal position may by its encroachment upon other viscera interfere with their functions.

Among the records of 8842 autopsies Morris[1] found 10 instances of misplaced kidney, the kidney lying either in the iliac fossa, in front of the sacro-iliac joint, in front of the promontory of the sacrum, or in the hollow of the sacrum. The kidney under these circumstances may be bodily displaced or may be rotated on any of its axes, and is not infrequently separated from its suprarenal capsule.

In a few cases malposition of the left kidney has been associated with malformation of the sigmoid flexure, which then is represented by a continuation of the descending colon to the right sacro-iliac joint, where the rectum begins.

Misplacements of the kidney either exist at birth or are effected by disease of neighboring organs; thus the right kidney may be displaced by pathological conditions of the liver, the left by enlargements of the spleen or pancreas, and either kidney may be displaced by tight lacing or by the pressure of tumors.

There are usually no symptoms referable to the misplaced kidney itself, unless it be diseased, but the kidney by its pressure upon other organs may give rise to symptoms of interference with their functions.

Malformations of the kidney vary from the lobulated condition which exists in the fetus and in many other mammals, to the single disk-shaped organ the result of fusion of the kidneys.

The lobes of the lobulated form correspond more or less accurately to the number of divisions of the ureter, the calyces; and there may, therefore, be as many as ten or there may be but two, representing the main branches of this duct.

Of fusion of the kidneys the so-called horseshoe kidney is the commonest type. In this the lower ends of the kidneys are united by a band of kidney-tissue or of fibrous tissue which extends across the spinal column, or, more rarely, the upper ends or the middle portions of the kidneys are so united.

An exaggeration of this form results in coalescence of the internal borders of the kidneys in their whole extent, making a single disk-shaped kidney, which is not infrequently displaced.

While in such cases there may be two separate pelves, there is as often one, but two ureters are present and discharge into the bladder in the usual way.

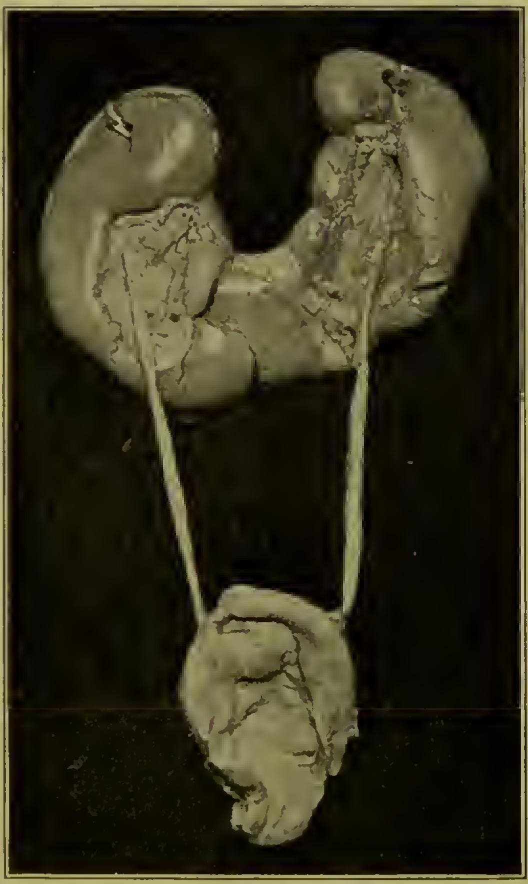

FIG. 194.—Horseshoe kidney (Specimen 3137, Museum N. Y. Hosp.).

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[1] *Surg. Dis. of the Kidney*, p. 19.

The failure of development of the kidney is of great surgical importance; and that such cases do occur should constantly be borne in mind in considering any operation upon this organ, but especially in connection with nephrectomy.

The horseshoe- or disk-shaped kidney naturally falls into the group of single kidneys, but has already been described, so that we include only those instances of kidney without a fellow or with an associated organ of rudimentary development and incapable of performing renal functions.

The absence of one or other of the kidneys has been frequently observed, although the proportion of such cases is exceedingly small—1 in $3992\frac{2}{3}$ (Morris). In these cases, however, the functions of the kidneys are carried on perfectly well by the kidney present, which is then usually hypertrophied.

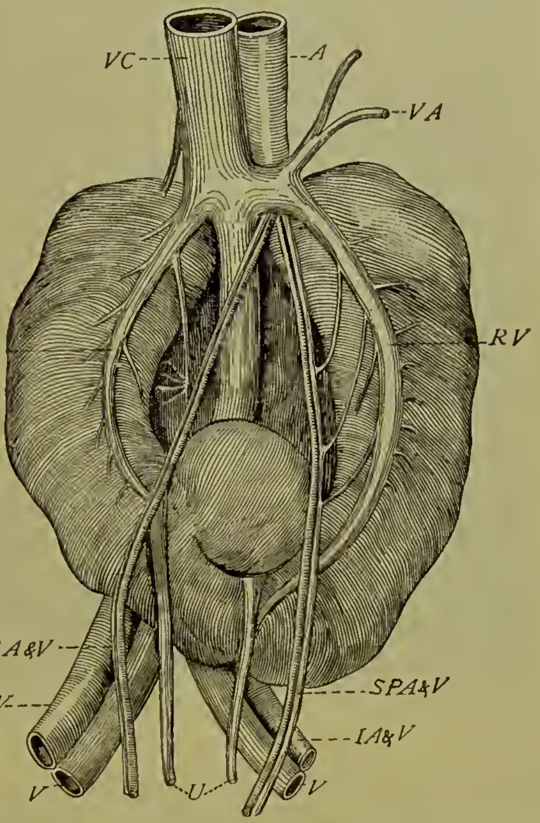

Fig. 195.—Two kidneys blended and occupying a median position: *A*, aorta; *VC*, vena cava; *VA*, vena adiposa; *RV*, renal vein; *SPA&V*, spermatic artery and vein; *IA&V*, iliac artery and vein; *U*, ureters; *V*, iliac vein (after Haller).

As to the relative frequency with which the right or left kidney is absent or rudimentary, Beumer's[1] statistics show that among 48 cases the right kidney was absent 22 times, the left 21 times, while one or other was rudimentary in 4; 1 not stated.

The causation of this condition has generally been ascribed to interference with the development of the Wolffian body; and the quite frequent association of absence of the kidney with absence or maldevelopment of other parts of the genito-urinary tract of the same side tends to support this view, as of the testis or ovary and of the uterus or seminal vesicle.

The rudimentary development of one of the kidneys depends obviously upon a lesser degree of the same interference with the growth of the Wolffian body that produces non-development of the kidney in other cases.

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[1] Quoted by Wagner: *Nieren-chir.*, p. 6.

The degree of non-development varies from some diminution in size to a mass of fibrous tissue in which only a trace of kidney-tissue is found, and which may properly be judged to be inadequate for the performance of excretory functions should the other kidney be removed.

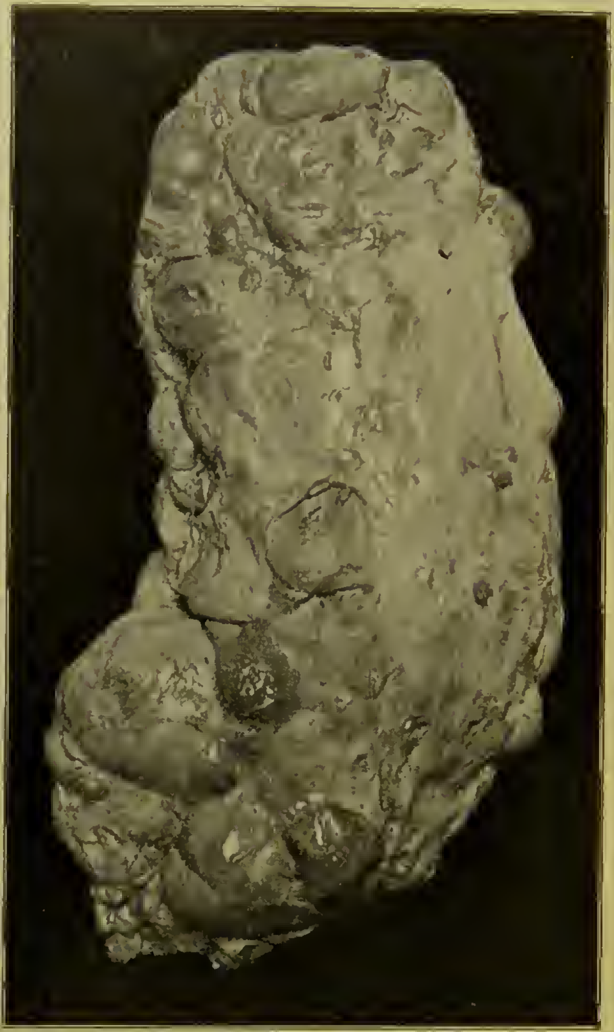

FIG. 196.—Congenital cystic kidney (Specimen 2816, Museum N. Y. Hosp.).

EXAMINATION OF THE KIDNEY.

Besides the knowledge of the state of the kidney to be derived from chemical and microscopic examination of the urine, and from cystoscopic inspection of the mouths of the ureters or their catheterization, direct investigation of the kidney is practised to ascertain its position, size, mobility, outlines, consistency, and relation to other organs.

Unless the kidney be considerably enlarged or displaced no information can be obtained by inspection. In many if not most persons the kidney, even when of normal size and situation, may be readily felt in its lower half; but where there is an extraordinary amount of fat present in the abdominal wall, or the latter is rigid, or the ribs very oblique and the lower opening of the thorax contracted, or where the colon is distended by fecal material, the kidney can hardly be recognized: it is further obvious that examinations made under anesthesia are far more certain and satisfactory.

Israel[1] gives three methods for palpating the kidney, and emphasizes the necessity of employing none to the exclusion of the others, as each yields information peculiar to itself.

The ordinary bimanual examination is made with the patient supine upon a flat surface, the thighs flexed, and abdominal wall relaxed. If the right kidney is to be examined, the operator stands upon the patient's right and places the fingers of the left hand beneath the loin, and the palmar surface of the fingers of the right hand upon the anterior abdominal wall in a line erected from the middle of Poupart's ligament to the cartilage of the eighth rib and two fingers' breadths below the costal cartilages; then the patient is directed to breathe rather deeply and easily through the mouth, and with each expiration the right hand crowds the abdominal wall backward, holding during inspiration the position previously gained until the kidney is reached, when with the counter-support of the left hand such facts as are sought are learned.

Guyon's method of kidney ballottement is practised with the patient and operator in the same positions, but in addition to the usual maneuvers above described the fingers of the hand upon the loin are repeatedly and sharply flexed, and thus reflex contraction of the quadratus excited, and the kidney is thrust forward against the anterior abdominal wall. This method is of special value in differential diagnosis, for no other abdominal tumor will give this sign.

The third method consists in placing the patient upon his side, or even semi-prone, with the thighs flexed. In this position the abdominal wall is relaxed and the abdominal contents fall away from in front of the kidney to be examined, and the latter may then be reached by the same bimanual compression as before.

In special cases palpation of the kidney may be carried out in the knee-chest or erect position—*i. e.* to ascertain the limits of the excursion of a movable or floating kidney.

The determination of the position or presence of a kidney by percussion is of questionable value.

In those forms of surgical disease of the kidney, then, which are accompanied by enlargement and by probable displacement the organ may be studied by palpation, and many of its features recognized; but the demonstration of an abdominal tumor to be of renal origin requires the consideration of many points, and especially if the tumor is of some size.

The lateral position of the tumor and its emergence from beneath the ribs, and its growth downward and toward the median line, are of great significance; or, if it possess some mobility, its recession to the loin in recumbency and the development of renal ballottement are valuable signs.

The comparative absence of respiratory movements will sometimes distinguish renal tumors from those of the liver, gall-bladder, and spleen.

Finally, the relation of the inflated colon to the suspected tumor will occasionally clear up a diagnosis otherwise uncertain; but it should be borne in mind that on the right side the ascending colon is usually found crossing the lower and inner part of a renal tumor, and is sometimes displaced inward, so as not to be detected on the anterior surface of the mass at all.

The introduction of an exploring needle or aspirator into a tumor previously demonstrated to be of the kidney is often of value in determining the presence or absence of fluid, and, in case fluid be present, in deciding its nature.

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[1] *Berlin. klin. Woch.*, 89, Nos. 7 and 8, pp. 125, 156.

It goes almost without saying that this exploration should be done aseptically and through the loin.

Kidney tumors have been confounded with those of the retro-peritoneal glands, of the gall-bladder, of the liver, of the spleen, of the intestine and mesentery, of the uterus, of the ovary, of the pancreas, and with tuberculous peritonitis; and the differentiation from tumors of these organs must depend upon a close study of all the facts of the case.

INJURIES OF THE KIDNEY.

Contusions of the Kidney.—The kidney may be contused by falls or blows in which the loin receives the violence, as by kicks or by falls across beams, but in its severer forms, at least, is usually found associated with the multiple injuries occurring in "run-over" accidents or in crushes between buffers or in elevators, etc.

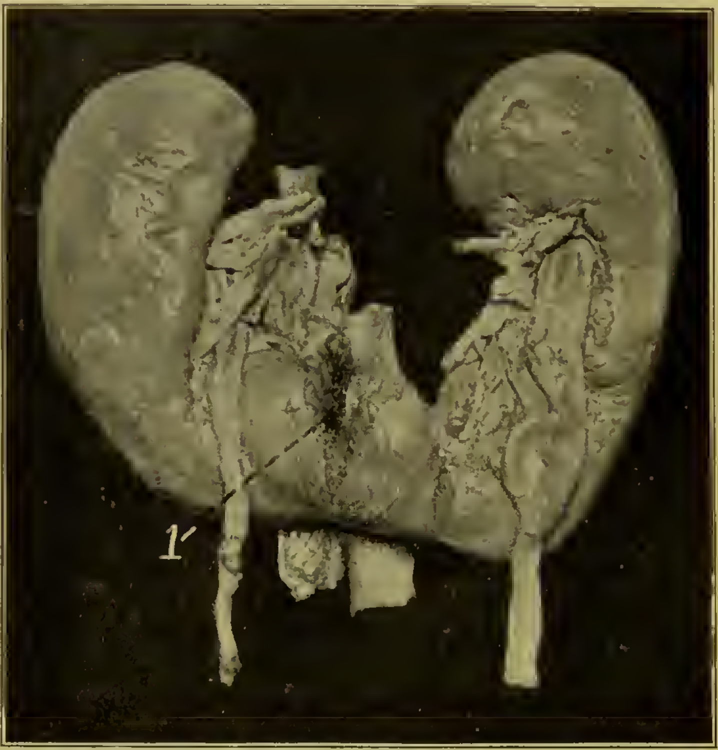

FIG. 197.—1, Rupture of the isthmus of a horseshoe kidney by fracture of the lumbar spine (Specimen 2930, Museum of N. Y. Hosp.).

Lesions.—The mildest form consists in small hemorrhages beneath the capsule of the kidney, without serious injury of the parenchyma. In the more severe cases laceration of the gland itself occurs, and hematomata of greater or less size are found, particularly at the bases of the pyramids.

In the most severe cases the kidney is ruptured or reduced to pulp, the capsule is split, and hemorrhage occurs into the surrounding tissues, and, if any considerable branch of the artery is torn, may be profuse and the effusion extend behind the peritoneum into the pelvis. In cases of this degree, and indeed in the milder ones, the neighboring structures are often injured.

The overlying peritoneum may be ruptured and the bleeding occur into its cavity; the liver, spleen, the intestine, and lung are sometimes injured, as well as the spine, ribs, and pelvis.

Repair of the kidney-tissue after contusions is usually rapid, but occasionally cysts are formed which persist indefinitely, or the injured kidney may be infected through the bladder and ureter or by the blood.

Symptoms.—After the reception of an injury severe enough to produce a contusion of the kidney the patient is usually in a condition of shock more or less profound. The skin is pale, cold, and moist, the temperature subnormal, and the pulse small, rapid, and feeble.

The symptoms of the accompanying injury may modify the picture, but certain well-defined features should serve to make the diagnosis of contusion of the kidney clear in most cases.

The pain is often agonizing, and, while always felt in the region of the kidney, generally radiates through the iliac fossa in the direction of the ureter, or, when clots are traversing the ureter, the pain is that of renal colic: under these circumstances clots have sometimes been discovered in the urine, and these resemble vermicelli and seem to be casts of the ureter.

The urine very soon after the injury generally contains blood in greater or less quantity, and may in serious cases be present in sufficient quantity to coagulate, or the loss of blood by this means may be great enough to produce death.

The hemorrhage may continue for some time, but, as a rule, diminishes after a few days, and ceases at the end of six or seven days.

More rarely blood does not appear in the urine for some days, or, instead of gradually diminishing in quantity, it may increase.

If the injury to the kidney is associated with rupture of the ureter, no blood, or at least very little, escapes into the bladder; but, as a rule, one may say that the amount of blood in the urine is a very fair guide to the degree of damage of the kidney.

The quantity of urine secreted after contusion of the kidney is diminished, and for a short time there may be suppression, but after a few days the volume of urine rises to the normal again.

Palpation of the kidney, when the pain excited does not forbid it, will occasionally reveal the existence of fulness, or, more rarely, of a well-limited tumor, indicating in the one case perirenal hemorrhage, and in the other distention of the kidney by blood confined within the capsule.

Ecchymosis, if it appears at all, is late in developing, and may be recognized in the loin or inguinal region.

If suppuration occurs, it is usually due to infection of the bladder by catheterization and to invasion of the kidney by the bacteria through the ureter. The form of inflammation may be either pyelo-nephritis, or one or more abscesses of the parenchyma of some size, or phlegmon of the perirenal cellular tissue.

The advent of a process of this kind is indicated by diminution in the quantity and change in the quality of the urine, by chills and febrile movement, and by pain and tenderness in the region of the kidney, and increase in the tumefaction there; the danger to life of such a condition is of course much enhanced if the other, non-contused, kidney is also affected.

As remote symptoms of contusion of the kidney, hydronephrosis, chronic diffuse nephritis, renal calculi, cysts, and tumors should be mentioned.

The **prognosis** is grave, and becomes especially so when the lesion is associated with severe injuries of other parts; thus Tuffier[1] gives the mortality of essentially uncomplicated cases as 43 per cent., and of complicated cases as 87 per cent. Grawitz[2] analyzes 108 cases as follows: Mortality,

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[1] *Arch. gén. de Méd.*, t. xxii. pp. 591, 697 ; xxiii. 335 .

[2] *Arch. für klin. Chir.*, Heft 2, 1889.

46.3 per cent., 50 cases, and of these fatal cases 18 were complicated by injury of more important viscera. In 17 suppuration occurred, with 7 deaths. Of 32 uncomplicated cases in which death followed, 14 died of primary hemorrhage, 8 of secondary hemorrhage, 7 of suppuration, and 3 of urinary retention.

Treatment.—The management of the injuries which may possibly be associated with contusion of the kidney need not be described here, nor is it desirable to do more than to refer to the necessity of combating shock if present in any degree.

The milder cases of contusion of the kidney need no further treatment than rest in bed for a few days and attention to the general condition of the patient.

In the more severe cases, where active measures to restrain dangerous bleeding come into consideration, no time should be consumed, in the writer's judgment, in waiting for the effect of drugs said to possess hemostatic properties in renal hemorrhage, nor in applying cold or pressure to the region of the affected kidney, nor yet in the use of cold enemata.

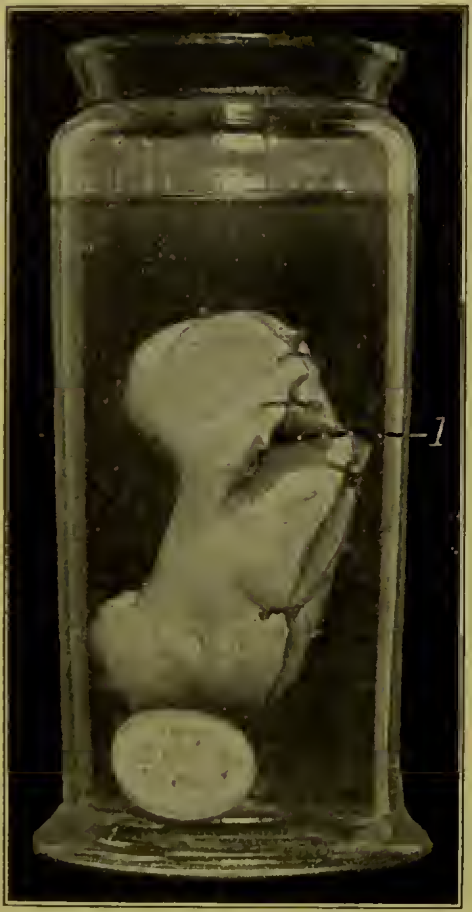

Fig. 198.—1, Stab wound of border of kidney, opening pelvis (Specimen 749, Museum N. Y. Hosp.).

If the bleeding is severe enough to be dangerous, one ought to proceed without delay to direct treatment of the kidney through an incision in the loin.

The perirenal region must be cleared of clots, and bleeding from the ruptured kidney controlled by gauze packing, by ligature or clamp, or by total or partial nephrectomy.

In the most severe cases, in which contusion of the kidney plays a rôle secondary to the associated injuries, no surgical interference is likely to prove of value, and none should be undertaken.

The treatment of the later complications will be discussed under their proper headings.

Wounds of the kidney are comparatively rare except in military practice, so that the majority of the cases reported have been either gunshot or stab wounds reaching the kidney through the anterior abdominal wall or the loin or the thorax.

Lesions.—All parts of the kidney have been wounded; the wound may be superficial or deep, or the kidney may be perforated or even cut into two pieces. In any case there is free bleeding, but especially in wounds near the hilus dividing the larger branches of the artery.

Neighboring organs may be also wounded; thus in a case occurring at the New York Hospital some years ago a 38-caliber bullet entered the anterior thoracic wall, traversed the pericardium, pierced the diaphragm, wounded the spleen, perforated the colon in four points, wounded the border of the left kidney, and lodged beneath the skin of the loin. In cases of this kind the wound of the kidney ceases to be the main feature of the injury.

Wounds of the kidney are readily and quickly repaired, and are not complicated by infiltration of urine, as might be expected; but if infection of the wound occurs, suppurative nephritis may develop and destroy the wounded organ.

Symptoms.—The shock which accompanies wounds of the kidney uncomplicated by wounds of other tissues is generally not very profound.

The position of the wound in the loin is of great significance, and more particularly its direction, which may be ascertained by placing the patient in the position occupied when wounded and then introducing the probe. If bleeding from a wound of the loin and leading in the direction of the kidney is profuse, the probability that the kidney has been wounded becomes very great; if urine escapes from the wound, there is no doubt that the kidney has been wounded, and very little doubt that the pelvis is also wounded; but this sign is comparatively rare. Hematuria is often, though not always, present. Without one or other or both of these signs the diagnosis of wound of the kidney remains in doubt.

In wounds of the kidney inflicted through the anterior abdominal wall the diagnosis becomes more difficult, owing to the very frequent wounds of the intestine produced by the same injury, and whose symptoms are likely to overshadow those of the wounded kidney.

Under these circumstances, unless a wound of exit also exists in the loin, or the bullet, in case of a bullet-wound, can be recognized beneath the skin of the loin, or hematuria occurs, the demonstration of a wound of the kidney is wellnigh impossible, and can only be made after the abdomen is opened for exploration or for the treatment of wounds of the other abdominal organs.

In a few instances the kidney has prolapsed through large wounds of the loin.

If the wound of the kidney is infected and suppuration occurs, the symptoms will be those of pyonephrosis, or if the kidney is infected by bacteria finding their way to it through the ureter from the bladder, the symptoms will be those of pyelo-nephritis.

Prognosis.—Wounds of the kidney alone are not of great gravity if they remain aseptic, as is shown by the almost uniform recovery after explorative incisions into the kidney; but the very frequent association of wounds of other abdominal viscera, giving rise to peritonitis, and the great likelihood of infection by foreign bodies, etc., and the possibility of peritonitis developing without wounds of the intraperitonal viscera, make wounds of the kidney grave injuries.

Thus, of 31 stab wounds of the kidney, 8 were fatal—25.8 per cent.; and of 38 bullet-wounds, 16 were fatal—42.1 per cent. But of the 8 deaths, 6 were at least caused in part by other visceral wounds; and of the 16 deaths, 11 were ascribed to lesions of other viscera.[1]

Grawitz[2] analyzes 50 cases of stab of the kidney as follows: 15 complicated by injuries of other viscera, 35 uncomplicated. Of the 35 uncomplicated cases, 11 died—1 from primary bleeding, 1 from secondary hemorrhage, 6 from suppurative nephritis of the wounded kidney, 2 from suppuration of the uninjured kidney, 1 not stated. Of the 15 complicated cases, 3 were complicated by injury of the spine, and all died; 1 by laceration of the peritoneum, fatal; 2 by injury of the liver, both died; 3 by injury of the intestine, 2 died; 6 by injury of the chest, 4 died; thus 12 died and 3 recovered.

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[1] *Traité de Chir.*, Duplay and Reclus, vol. vii. p. 492.

[2] *Arch. für klin. Chir.*, Heft 2, 1889.

Treatment.—If the external wound is situated in the loin and bleeding is slight, and there are probably no foreign bodies to deal with, after sterilization it may be lightly packed and a large firm dressing applied.

If, however, there is dangerous bleeding or foreign bodies come into question, the kidney should be exposed by an incision which includes the wound if possible; the hemorrhage treated either by gauze pressure, suture, ligature, or clamp, or total or partial nephrectomy performed. If the wound be situated in the anterior abdominal wall and has traversed the peritoneal cavity to reach the kidney, it is likely that some other of the abdominal organs has been wounded: to determine this point, as well as to treat the wound of the peritoneum which overlies the kidney, and the kidney wound itself, the safest course to pursue is to enlarge the wound of entrance sufficiently to examine the intestine in the neighborhood. If wounds of the small intestine are found, the abdomen must be opened in the median line to a sufficient extent to allow proper treatment of the intestinal wounds, as well as to give access to the injured kidney.

On the other hand, if the external wound is situated in one or other lumbar region and the ascending or descending colon is the portion of the bowel wounded, Langenbuch's incision through the linea semilunaris will give the most satisfactory path to the kidney and the intestine.

The wounded kidney is then treated as advised in the case of wound through the loin, but if extirpated the cavity should be drained through a counter-opening in the loin.

If extirpation is not found necessary, the peritoneal wound must be firmly sutured, the contiguous peritoneum wiped clean, and provision for the escape of secretion provided by gauze drainage.

Irrigation of the entire abdominal cavity would hardly be indicated unless considerable quantities of blood or urinous fluid had produced a general soiling of the peritoneum; but if the peritoneum is in a condition that seems to warrant active treatment, the flushing must be thorough, and is better done by salt solution than by antiseptic solutions, which, if concentrated enough to be germicidal, are powerful irritants of the peritoneum; and irrigation must be supplemented by drainage, not only of the region of the affected kidney, but also of Douglas's cul-de-sac and the opposite lumbar region.

If the kidney is prolapsed through a wound of the loin and uninjured or only slightly wounded, it should be replaced and the wound thoroughly drained; if so damaged, either by extensive wound or by strangulation, as to render it useless, the pedicle must be tied off and the organ removed.

If infection of the wound occurs, either from without or by way of the ureter, the condition is one of pyelonephritis or of pyonephrosis, and will be discussed under those titles.

SUPPURATIVE INFLAMMATIONS OF THE KIDNEY, OF ITS PELVIS, AND OF THE PERIRENAL TISSUES.

Suppurative inflammations of the kidney or of its pelvis, or of both together, occur under a variety of circumstances; but since suppuration is common to them all, and the lesion is of the same character, differing only in degree, it is convenient to class all these inflammatory diseases in one group, and thus to avoid a great deal of repetition that would inevitably be involved in separate descriptions of them.

Lesions.—In those forms produced by embolism, and occurring in conditions of general sepsis or associated with infectious endocarditis, both kidneys are usually involved: they are slightly increased in size, deeply congested, and studded with minute white points surrounded by red zones. These dots are formed by the infiltration of pus-cells between the tubules of the kidney and the disintegration of the kidney tissues; they teem with the bacteria of suppuration.

In those forms caused by extension of the suppurative process from the pelvis of the kidney or the ureter one kidney only may be involved, or both. The kidney is swollen, congested, and studded with foci of pus of various sizes, which are infiltrated between the tubules of the cortex and pyramids; in the latter the foci often appear as streaks running parallel with the collecting tubules. As the disease goes on larger abscesses occur through confluence of the smaller ones, until the entire kidney may be destroyed and the perinephritic tissue infected. The pelvis of the kidney is swollen, congested, coated with pus or fibrin, or ulcerated.

If the disease is slow in its evolution, and particularly if the ureter is more or less obstructed, the pelvis and kidney become distended by a mixture of pus and urine, and the resulting condition is referred to as pyonephrosis.

Such abscesses may rupture spontaneously through the skin or diaphragm or into the intestine or peritoneum.

In suppurative nephritis consequent upon contusions or wounds the resulting process may be circumscribed and confined to one part of the kidney, or the whole gland may be involved and converted into a mass of blood, pus, and broken-down tissue.

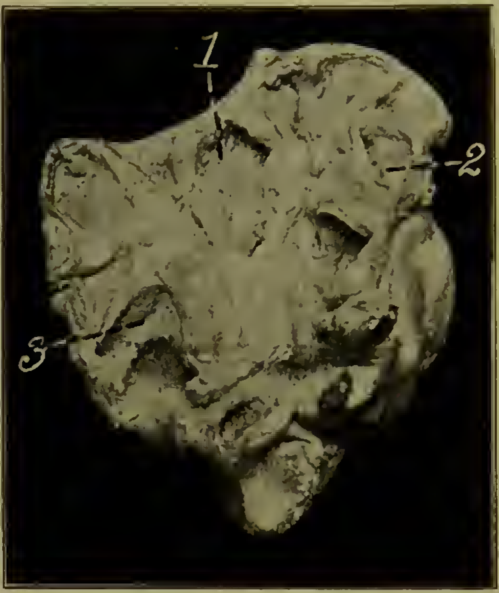

FIG. 199.—Suppurative nephritis: 1, 2, and 3, abscess-cavities (specimen 2386, Museum N. Y. Hosp.).

Any of these forms of inflammation may extend beyond the kidney, either by rupture of the abscesses into the surrounding tissues or by transmission of the bacteria along the lymph-channels; and when perinephritis does develop, considerable collections of pus may occur about the kidney.

Suppurative inflammations of the perinephritic tissues also occur as primary phlegmons, and run a rapid and severe course; or the inflammation may be propagated from contiguous organs other than the kidney, as the lumbar spine, pelvic cellulitis, appendicitis, etc.

Abscesses of the perirenal tissues usually rupture externally in the loin, but they may burst into the pleura or lung, the intestine or peritoneum, or they may burrow downward through the iliac fossa to the groin and perforate the skin.

Etiology.—All of these forms of suppuration are caused by the presence and growth of one or other of the pyogenic bacteria, oftenest the golden coccus, but not infrequently the common colon bacillus. The channels by which these bacteria reach the kidney, however, are quite varied.

In the cases of miliary abscesses occurring in sepsis or complicating malignant endocarditis the blood conveys the bacteria, and the process is one of embolism, and suppuration goes on wherever the cocci happen to lodge.

In suppurative nephritis due to infection from the pelvis of the kidney the pelvis of the kidney is usually invaded by bacteria reaching it through the ureter from the bladder, where, as a rule, they are present as the result of instrumentation or the extension of inflammations of the urethra.

The conditions which call for the introduction of instruments into the bladder are therefore usually the antecedents of this type of nephritis, and in such cases one finds an acute or chronic cystitis due to gonorrhea or strictures, or hypertrophy of the prostate, or produced by operations upon the urethra or bladder, or, in cases of paraplegia, in consequence of catheterization.

The inflammation originating in the bladder ascends the ureter and pelvis of the kidney and the straight tubules, and then excites the changes above described.

If the pelvis of the kidney happens to contain calculi, they will be found in the abscess-cavities: they appear to act as causative agents in the production of suppuration only to the extent of making the action of the bacteria easier by their mechanical irritation of the tissues involved; or if they partially obstruct the ureter and prevent the free escape of what urine may be secreted and of pus, they may contribute in this way to the development of pyonephrosis.

In suppurative nephritis consequent upon contusions or wounds of the kidney, the bacteria gain entrance to the organ through the external wound, or in the case of contusions through the bladder, ureter, and pelvis, and generally as the result of catheterization, unless some suppurative lesion of their mucous membranes already exists.

Symptoms.—The minute abscesses which occur with general sepsis or with malignant endocarditis give no symptoms that indicate with certainty the condition of the kidneys present; for the occurrence of albumin and casts in the urine is the rule in septic diseases, even without embolism of the kidney.

With the larger abscesses due to injuries of the kidney, or to the presence of calculi, or to uretero-pyelitis, the symptoms are generally well marked and the change in the kidney often capable of easy demonstration; but they differ slightly in their details. When the nephritis occurs with cystitis due to stricture of the urethra, to operations on the urethra or bladder, or to vesical calculus, the patient suffers first from the symptoms of cystitis, and then from the symptoms of nephritis; there are repeated chills and a febrile movement of an irregular type and accompanied by sweating.

Cerebral symptoms become marked; delirium alternates with stupor; the periods of stupor become longer; and the patient finally dies in a state of profound sepsis.

The urine is usually diminished, and may be suppressed, and contains blood, pus, and mucus derived from the bladder and the kidneys.

When the nephritis is due to the extension of a gonorrhea to the kidneys, the patients first suffer from the gonorrhea, and then from cystitis, and last from nephritis. The latter adds about the same symptoms above described; these cases are rare.

When suppurative nephritis complicates hypertrophy of the prostate, the patients are men generally more than fifty-four years of age, who have suffered for longer or shorter periods from the symptoms of enlargement of the prostate, retention, and cystitis, and have been obliged to use the catheter; or, more rarely, there have been no bladder-symptoms.

"The first symptom is a diminution in the quantity of urine, with the appearance of blood mixed with it, or the urine may be suppressed altogether. The blood may be present in considerable quantities, so that the patients seem to pass blood instead of urine. The patients rapidly become prostrated, and are very anxious. There are usually no chills, and there may be no rise in temperature. The prostration becomes more marked; the pulse is rapid and feeble; the skin is cold and bathed in perspiration; and the patients die in collapse at the end of a few days. Or, instead of such a history, the patients may behave as if they were the subjects of septic poisoning" (Delafield).

In these forms of suppurative nephritis both kidneys are commonly involved, but, aside from some pain referred to the loins, there may be no local symptoms, and the slight enlargement of the kidney present is rarely demonstrable.

When suppurative nephritis occurs without assignable cause, or when pyelitis excited by the presence of calculi becomes infected from any source and extends to and involves the kidney, the disease is apt to run a slower course.

The patient may have suffered from the symptoms of renal calculi when he develops the symptoms of suppuration; they are at first obscure. There may be repeated chills, and fever of mild and irregular type, with loss of flesh and strength. There may be pain referred to the affected kidney.

If the purulent collections communicate with the ureter, pus may be discharged continuously or at intervals; and in the latter case a tumor may be detected at the site of the kidney, which varies in size, and whose diminutions in size correspond to the presence of considerable amounts of pus in the urine.

If the abscess ruptures, fistulæ are formed which open externally or into one of the neighboring cavities. Protracted suppuration from this abscess may in the end cause amyloid degeneration of the other viscera, including the opposite kidney.

In suppurative nephritis consequent upon injury we get the history of injury, and then of sepsis.

In the case of a wound the diagnosis is quite easy, but in the case of contusion the symptoms usually begin with chills, which may be repeated, and at the same time aseptic fever develops: there may be pain referred to the affected kidney; the urine is diminished and continues to contain blood, and later pus appears. The enlarged kidney may sometimes be palpated. The disease may go on and the patient die in a typhoid state, or the course may be slower and give the symptoms of pyonephrosis, or the symptoms may gradually subside and the patient recover.

Perinephritis.—There is a form of inflammation of the pararenal cellular tissue which appears to be a primary phlegmon, with which the kidney has nothing to do.

More commonly, however, the perinephritic inflammation is secondary to suppurative nephritis, and then its symptoms are preceded by those of the condition to which it is the sequel.

The disease runs a rapid or less acute course; there are chills, fever, and pain. If the abscess points backward, the loin sooner or later swells and gives fluctuation, and the collection may rupture there; if the pus burrows downward, it may point in the groin; if it bursts into the peritoneum, the symptoms of septic peritonitis are developed; or the abscess may rupture into the intestine or perforate the diaphragm and cause empyema, or be discharged through the bronchi.

Prognosis.—Those forms of bilateral suppurative nephritis occurring with general sepsis, with enlarged prostate, with gonorrhea, with stricture of the urethra, or with vesical calculus are fatal in the vast majority of cases, very few recovering. Those forms of suppurative nephritis occurring in but one of the kidneys, and due to renal calculi and to injuries of the kidney, are slower and less severe in their courses, and the patients usually get well if treated with discretion, but many also die.

Perinephritis is not usually fatal, but large collections of pus may form and exhaust the patient, or, rupturing into the peritoneum, pleura, or lung, may produce death.

Treatment.—For the miliary abscesses occurring with general sepsis or due to infectious emboli there is practically no other treatment than that directed to the general disease: if this succeeds, as it rarely does, the lesion of the kidney heals, and the minute scars of these abscesses have been recognized at autopsy in the kidneys of those who had previously gone through such attacks and recovered.[1]

For the bilateral suppurative nephritides due to strictures, to enlargements of the prostate, to stone in the bladder occurring in persons of middle or advanced years, there is no treatment. In younger individuals the patient may recover, at least exceptionally, as an observation reported by Weir to the Association of American Surgeons (1894) will show.

For the abscesses of the kidney due to injury or occurring in consequence of calculi the indication is to drain as early as possible, in order to prevent extensive destruction of the kidney-tissue and to anticipate implication of the contiguous tissues.

The kidney is exposed in the loin, the pus located by the aspirating needle, and the cavity opened by the most direct route through the overlying cortex; if calculi are present, they are to be removed; the cavity is washed out and drained by a very large tube or by gauze. If great destruction of the kidney has occurred, it should be removed under the general conditions involved in considering Nephrectomy.

For acute primary perinephritis the treatment is that of cellulitis anywhere—namely, incision and drainage.

The treatment of secondary perinephritis is early incision and drainage, and then the treatment of the disease to which the perinephritis is due.

Pyelitis.—Inflammation of the pelvis of the kidney occurs with some frequency as part of the lesion of pyelonephritis, or as the effect of the presence of renal calculi, or of hydronephrosis, or as the result of obstruction to the escape of urine by strictures of the urethra or enlargements of the prostate; and under these circumstances is cured or benefited by the treatment of the main lesion.

Those forms of pyelitis which occur as primary inflammations are usually treated by medical means, and require no more than mention in this place.

Catarrhal inflammations of the mucous membrane are produced by certain poisons, as turpentine and cantharides, and occur with the exanthemata and with typhoid fever.

Acute purulent pyelitis occurs also as a primary inflammation in children; and for the report of three very interesting cases of this type of disease the reader is referred to a paper published by Holt in the *Archives of Pediatrics*, Nov., 1894.

Under the title of "hemorrhagic pyelitis," Delafield[2] describes a rare form of pyelitis characterized by intermittent attacks of pain over one kidney and bloody urine, or by bloody urine alone.

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[1] R. F. Weir, personal communication.

[2] *Lectures on the Practice of Medicine.*

Lesions.—The kidney-tissue is normal, and contains no blood in the tubes or stroma. The mucous membrane of the pelvis and calyces is thickened, its stroma is infiltrated, and the epithelium irregular. Only one specimen has been examined.

Symptoms.—The symptoms may be mild or severe.

The milder form of the disease seems to be of most common occurrence in young girls. There are occasional attacks in which, with little or no pain, red and white blood-cells and epithelium from the pelvic mucous membrane appear in the urine, and persist for indefinite periods; in addition, the patient suffers from hysteria and disturbances of digestion. These attacks recur irregularly, and after one or more may never reappear.

The severer form occurs both in males and females. These patients suffer from attacks of pain, and from profuse bleeding from the affected kidney. These exacerbations persist for a time, and then recur, or they may cease entirely; in any case, the symptoms resemble those of renal calculi so closely that in the few cases operated upon this has been the diagnosis.

Prognosis.—Spontaneous cure, or at lest cessation of symptoms, seems to be the rule in the milder cases, as also in some of the more severe cases.

Treatment.—In those cases in which, upon the supposed existence of calculi, the kidney has been operated on, cure has followed palpation, needling, splitting, and excision, so that nothing very definite can be said.

In the milder cases the treatment is chiefly symptomatic.

TUBERCULAR NEPHRITIS.

Tubercular inflammations may attack any portion of the genito-urinary tract, as the kidney, ureter, bladder, vas deferens, testicle, seminal vesicle, prostate, urethra, uterus, tubes, or ovaries.

Lesions.—In the kidney, with acute general miliary tuberculosis, miliary tubercles form, but, as a rule, give no symptoms.

In tuberculosis of the kidney, occurring as a primary inflammation or secondary to tuberculosis of some other part of the urinary tract, and reaching the kidney by extension, the destruction of the renal tissue varies in degree.

The kidney is increased in size, and not infrequently appears nodular and mottled; upon section there are found larger or smaller grayish-yellow foci, varying in size from a bird-shot to a marble or, rarely, much larger, and containing cheesy material or fluid pus, sometimes shut in by a delicate zone of connective tissue.

If the pelvis of the kidney is involved, as it usually is, the mucous membrane is thickened and may be ulcerated.

Along with this change in the kidney, in most cases there are tubercular inflammations of one or more of the other parts of the urinary tract above mentioned, and also of some more remote portion of the body.

In the most severe cases the renal tissue is entirely destroyed, and the organ represented by a large sac containing the disintegrated tubercle-tissue; or the ureter may be so much narrowed by thickening of its wall that distention of the kidney occurs as in hydronephrosis.

Tubercular nephritis begins in the stroma of the kidney, and results in the growth of tubercle-tissue and in degeneration and destruction of the epithelium; the tubercle-tissue soon undergoes necrosis and cheesy changes, and then may soften or calcify.

Those parts of the kidney not directly involved generally show the changes of chronic diffuse nephritis.

What is of special importance for surgeons to know is that the perirenal tissue is sometimes involved, and that then very tough adhesions may form between the kidney and contiguous organs, and render removal of the kidney a matter of very great difficulty, or even impossible: thus it has happened, even in skilful hands, that fatal laceration of the vena cava has occurred.

Etiology.—Tubercular nephritis occurs oftener in men than in women, and generally occurs between the ages of twenty and forty years, more rarely before than after this period.[1]

The disease may begin in the kidney itself as the result of lodgement in the organ of tubercle bacilli carried there by the blood, to which they have gained entrance by one or other channel; or the tubercular inflammation may spread to the kidney from the testis, for instance, by way of the vas deferens, prostate, bladder, ureter, and pelvis.

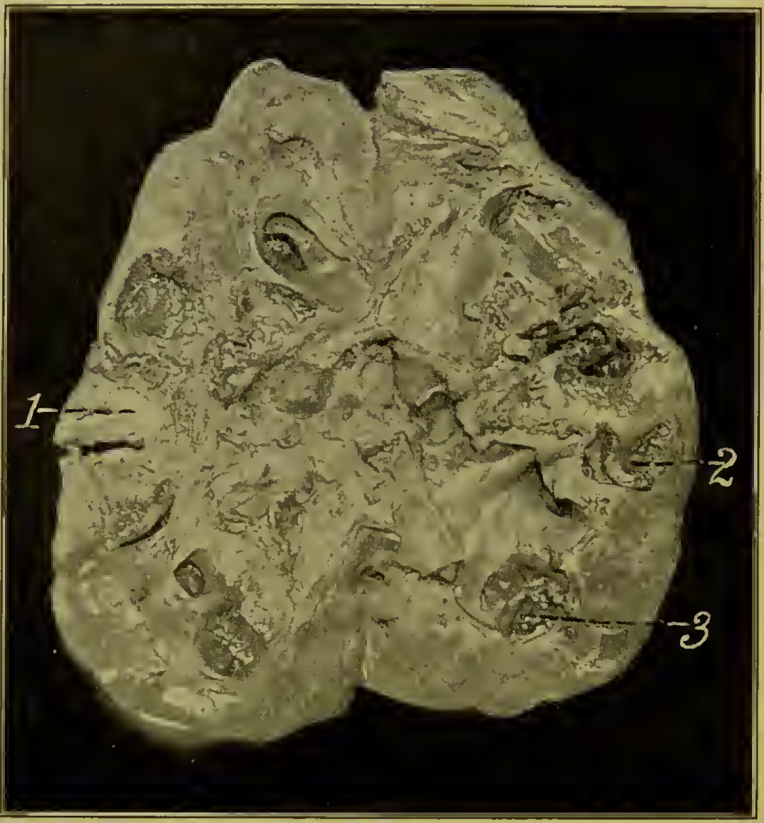

Fig. 200.—Tuberculous nephritis: 1, cheesy focus; 2 and 3, abscess-cavities (Specimen 2931, Museum N. Y. Hosp.).

Of these two ways, the primary, embolic form is probably more rare than the forms in which the kidney is involved secondarily to tuberculosis of the ureter and pelvis, but it is said to be of more frequent occurrence than has heretofore been supposed.[2]

Symptoms.—Those cases of tuberculosis of the kidney which, in fact, are only part of acute general miliary tuberculosis give no symptoms referable to the kidney other than those of acute degeneration belonging to infectious diseases.

Whether the tubercular nephritis is primary, and the mucous membranes lower down are secondarily infected, or the nephritis itself is secondary, after the disease is well established, there are tolerably well-marked changes in general health, in the function of micturition, and in the character of the urine.

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[1] Those cases of miliary tubercles of the kidney occurring in acute general miliary tuberculosis are not included.

[2] Rosenstein: *Nierenkrankheiten*, p. 540.

The urine is usually unchanged in quantity and of good specific gravity at first, but contains, more or less constantly, blood, pus, shreds of tissue, and bacilli in varying quantities, depending in great measure on the extent of the lesions of the mucous membranes and on the presence or absence of communications between the foci in the kidney and its pelvis.

Later, when changes have occurred in the other kidney, the specific gravity may fall and the quantity of urine be increased.

Bacilli are not always present; indeed, it is the exception to find them; but, curiously enough, urine in which they cannot be detected is sometimes capable of exciting tubercular peritonitis in guinea-pigs.

There are almost always frequency of micturition and more or less tenesmus; and it is these symptoms which usually lead the patient to seek advice.

There is usually pain, referred to the region of the affected kidney, often increased during the tenesmus which accompanies micturition.

The affected kidney is tender to palpation, and may often be recognized to be considerably increased in size; in exceptional cases one may detect fluctuation or even the nodular outline of the kidney so often present.

In men, particularly, tubercular lesions of other parts of the genito-urinary tract are present, and are of great value in forming a diagnosis; thus one may find tubercular epididymitis or tubercular spermato-cystitis, and with the cystoscope it is possible at times to discover ulcers in the wall of the bladder.

There is more or less fever, which is apt to assume a hectic type and to be accompanied by sweating.

The patient loses flesh and strength.

Later there may be developed the symptoms of pulmonary tuberculosis, tuberculous peritonitis, or other local tuberculosis, or at any time the patient may die from acute general tuberculosis.

Prognosis.—Acute general miliary tuberculosis is regularly fatal. Tubercular nephritis is ordinarily slow in its evolution, and usually requires several years to run its course and terminate fatally by one or other of the complicating lesions.

In that form, the so-called ascending type, in which the whole tract is more or less involved from the testis to the kidney, no surgical treatment is likely to avail much; but where the kidney is primarily attacked and the diagnosis made early, and extirpation of the kidney promptly carried out, there is promise of a permanent result.

Treatment.—For acute general miliary tuberculosis there is no treatment.

For those cases in which tuberculosis of the kidney is combined with similar lesions of other organs the treatment must be chiefly medical, and include the consideration of climate, hygiene, and medication. But even in these cases, if the kidney is much enlarged, and what might be described as a tubercular pyonephrosis exists, the patient may be made more comfortable, and his life perhaps prolonged, by drainage of the sac or even its extirpation.

At this place one should emphasize the importance of preventing the development of those forms of ascending tubercular nephritis secondary to tubercular epididymitis by removing the testis at the earliest moment.

It is, however, in cases of primary tuberculosis of the kidney that removal of the kidney offers the most promising results, for here a tuberculosis is to be dealt with which is purely local, and under these circumstances nephrectomy is most highly recommended.[1]

The following figures from Tuffier[2] will show the results of nephrotomy for tuberculous nephritis, 25 cases:

Mortality	47.8	per cent.
Fistulæ	18.2	"
Relapses	26	"
Cures	8	"

Primary nephrectomy, 57 cases:

Mortality	32.3	per cent.
Abdominal	36.3	"
Lumbar	28.2	"

That primary nephrectomy may yield lasting cures is shown by the same writer in mentioning: 1 case followed for eight years; 2 cases, five years; 3 cases, three years; 4 cases, two years—all without recurrence.

For the treatment of the complicating tubercular lesions of the other parts the reader is referred to the sections on the organs in question.

RENAL CALCULUS.

The solid constituents of the urine may be deposited in the kidney or its pelvis in the form of sand, gravel, or calculi.

The calculi consist of uric acid or of uric acid with a shell of oxalate of lime, or of phosphates, or of oxalate of lime, or of phosphates, or carbonates; these calculi are all stony.

Calculi composed of cystine are of a light-yellow color, lustrous, and resemble beeswax more or less; they are rare. Calculi consisting of xanthine, of fatty or saponaceous matters, or of fibrin, or of indigo are exceedingly infrequent.

In general terms, the number of calculi in a given case varies inversely with their size: when their size is small the number may be very great, as many as two hundred having been found in a single kidney; conversely, when their size is large the number is usually small, and there are seldom more than four or five; but small-sized calculi may also occur alone, and large calculi are sometimes found along with considerable quantities of grit, indicating the probable mode of growth of the calculus.

The largest calculi may fill the entire pelvis of the kidney and form very accurate casts of the calyces, pelvis, and more or less of the ureter, and weigh several ounces, but the average large calculus seldom exceeds a hickory-nut in size, while the smaller calculi, occurring in considerable numbers, are usually about the size of peas.

Gravel consists of granules small enough to traverse the ureter without difficulty, and in sand the particles are quite fine.

In outline the calculi vary widely. As we have seen, the largest may be accurate casts of the pelvis and calyces, but the commonest form is irregularly ovoid, with a rough surface which occasionally is facetted at one or two points, or they may be branched in curious ways.

The surface of the calculus is colored by the material which forms its cortex; thus the uric-acid calculus is reddish or brownish, and the phosphatic are a dirty white; but in any case the color of the calculus is apt to be modified in its fresh state by adhesion of more or less fibrin or through staining by blood or urine.

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[1] Rosenstein: *loc. cit.*, p. 556.

[2] *Traité de Chir.*, Duplay et Reclus, vol. vii. p. 575.

In consistency the uric-acid and oxalate-of-lime calculi are comparatively hard, while the phosphatic calculi are soft and friable; and when either of the first varieties is coated by phosphatic material, the latter may be very easily chipped off, and its presence indicates then the course of the disease which produced the calculus and the transition from acid to alkaline urine.

The calculi composed more or less of organic matters, cystine, etc. are usually not stony, but may become so, or may constitute the nucleus about which, subsequently, strata of other composition are deposited.

The different strata in the case of compound calculi are glued together by an albuminous material, which is probably the mucus secreted by the inflamed mucous membrane of the renal pelvis.

Calculi most commonly develop in the calyces or the pelvis of the kidney, or, more rarely, in the gland itself; and their presence in either position may not excite inflammation, or, on the other hand, suppuration may occur.

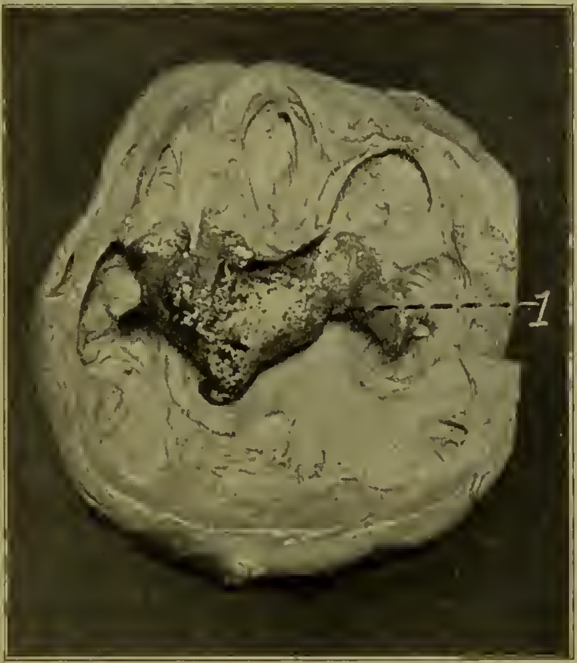

Fig. 201.—Calculous nephritis: 1, calculus *in situ* (Specimen 2677, Museum N. Y. Hosp.).

In case the calculus is formed in the parenchyma and is not accompanied by suppuration, very little or no disturbance of the function of the kidney is produced, at least until after the lapse of considerable periods, when the changes belonging to chronic diffuse nephritis develop, and in the end the kidney may be much atrophied.

If, however, the calculus sets up more acute inflammatory changes, and the region is infected either by the blood or by way of the ureter, abscess-formation occurs, and effects a very considerable destruction of renal tissue, and by bursting through the capsule of the kidney may cause perinephritis in one of its forms.

The calculus may be formed in the pelvis of the kidney, and remain there or in one of the calyces, generally adherent to or imbedded in the mucous membrane, without causing any very serious damage; or the stone may lodge in the upper end of the ureter, and by partially blocking its lumen cause gradual dilatation of the pelvis and kidney, and so produce hydronephrosis.

More commonly, however, the calculus excites inflammation of the mucous membrane of the pelvis, which sooner or later becomes infected; the infection extends to the kidney proper, and in the end the condition is one known as calculous pyelonephritis.

Conversely, a pyelitis, originating in one way or another, may cause the precipitation of the urinary salts, and thus provoke the formation of calculi, which are very appropriately called *secondary* to distinguish them from those formed before pyelitis has occurred.

Etiology.—Renal calculi occur at all ages, but in New York, at least, it is comparatively rare to find children suffering from this disease, though it is usually said that, like vesical calculi, they occur most commonly in childhood and middle and advanced life.

Males are more liable to the disease than females, the proportion being ordinarily said to be 3 to 1.

The heredity of the gouty diathesis will serve to explain the curious instances on record of renal calculi developing in father and son or in all of a group of brothers. In fact, it is to the gouty diathesis that the formation of calculi is usually ascribed; and such diathesis may exist at birth or may be acquired by a sedentary mode of life, coupled with the ingestion of rich articles of food, alcohol, etc.

The conditions which cause the precipitation of uric acid in the kidney are not altogether clear: they may exist at birth[1] or apparently develop at almost any period of life, depending, it would seem, upon some error in nutrition which prevents the complete retrograde metamorphosis of the nitrogenous substances of the body and their conversion into urea.

The occurrence of calculi composed of calcium oxalate is equally obscure, though the appearance of this salt in the urine is known to be associated with certain depressed states of the nervous system, included under the name "neurasthenia."

In either case the microscopic crystals are found to be fastened together in the calculus by organic material of an albuminoid character; and for the development of this cement it is stated[2] that a light desquamative catarrh of the mucous membrane must be assumed to coexist, and that without this "stone-producing catarrh," no matter how abundantly urinary sediments may be precipitated, no calculus can be formed.

The occurrence of phosphatic calculi or those composed of carbonates is much less difficult to understand, especially when they develop as the consequence of pyelitis, for in this case all the elements necessary are at hand.

The phosphates, insoluble in an alkaline menstruum, are precipitated, and the particles are glued together by the organic material exuded from the inflamed mucous membrane. Thus any one of the causes of pyelitis may finally be the cause of calculi.

The inclusion of calculi composed of uric acid in shells of phosphates is of some interest, because it indicates that a uric-acid calculus formed in the kidney, and remaining there with or without symptoms, grows by the addition of more and more uric acid, until from some source—generally from the bladder—the mucous membrane of the pelvis is infected and fermentation of the urine occurs; then phosphates are deposited upon the surface of the stone; and when it is finally examined it is found to consist of a nucleus of uric acid enveloped in a coat of phosphates.

The fact that cases of renal calculus occur more frequently in some regions than in others has called forth a good deal of speculation; but, except in the case of Egyptians, nothing very tangible has been discovered. In the calculi removed from the kidneys of persons living in Egypt the nucleus of the calculus is often found to be the ovum of a variety of parasite, the filaria Bilharzia.

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[1] Rosenstein: *Path. u. Therapie des Nierenkrank.*, p. 595.

[2] *Ibid.*, p. 608.

Symptoms.—Infrequently calculi of considerable size may form in the kidney and give no symptoms at all, or at most only trifling pain referred to the loin from time to time. Usually, however, the patients suffer from the presence of the calculus, from the changes which coexist in the kidney, and from the chronic inflammations of other tissues due to the gouty or other diathesis which is at the bottom of all.

The pain caused by the stone in the kidney varies in intensity in different individuals and in the same individual at different times; it is described as a gnawing, dragging sensation, referred to the region of the affected kidney which the patient attempts to relieve by pressure or by change of position. The pain often radiates toward the sacrum or inguinal region, or more rarely toward the bladder or even the other kidney; but its peculiarity consists in its aggravation by jarring movements, as horseback exercise, and also in its relief by rest or by change of attitude; indeed, for diagnostic purposes it is often of great value to excite increase of this pain by percussion of the kidney region or by bimanual compression of the kidney.

The form of pain which is of most significance in indicating that renal calculi are present is renal colic, which is usually due to the passage of a foreign body through the ureter.

Although the passage of a blood-clot may cause the same symptoms, in most cases the pain is due to a calculus, which may then traverse the ureter or lodge in it somewhere, or be returned to the pelvis of the kidney.

The pain is intense, and radiates from the kidney along the course of the ureter to the bladder or groin; to the testicle, which is then retracted, tender, and often swollen; to the labium majus or to the thigh. Exacerbations of the colic occur at frequent intervals, and the sufferings of the patient are so severe that he may lose consciousness or have convulsions. These attacks vary in duration from a few hours to several days.

Besides the pain, there is often rectal tenesmus, distention of the abdomen, vomiting, and constipation.

During the attack the urine is diminished in quantity, and is sometimes suppressed, as the effect of reflex influences exerted upon the other kidney, or as the result of both ureters being plugged by calculi at the same time.

The kidney is very tender, and may be increased in size, though this feature is difficult to demonstrate; tenderness is felt along the course of the ureter, and persists for some time after the acuter symptoms have subsided.

After the attack the urine is frequently increased in volume, and usually contains blood, mucus, and pus in considerable quantities, and occasionally the calculus escapes *per urethram.*

If the calculus remains in the bladder, it usually grows, and finally gives symptoms which demand its removal; if it remains lodged in the ureter, a tender point remains somewhere in the course of this duct, and a gradually increasing distention of the kidney—hydronephrosis—may develop.

During the height of the colic the appearances sometimes simulate biliary or intestinal colic, intestinal obstruction, or peritonitis, but the pain radiating from the loin, together with the results of the urinary examinations, will generally serve to prevent errors in diagnosis.

The urine, until pyelitis is provoked or bleeding produced, may give very little evidence of the existence of calculi: it may be extraordinarily acid and precipitate considerable quantities of uric-acid crystals, and, if chronic diffuse nephritis is at all advanced, the specific gravity is apt to be below 1020, and there may be a trace of albumin.

Hematuria is of great significance, and, although not always present, if it occurs, particularly under circumstances to be described, is wellnigh pathognomonic.

Besides the hematuria which accompanies or succeeds the passage of a stone through the ureter blood is usually to be found in the urine of patients suffering from calculi at other times.

The amount of blood is usually not large, nor does it persist for any period, and it seldom presents clots or casts of the ureter; but it does often occur as the so-called blood-casts; and unless the urine is alkaline the red disks are apt to be crenated.

The peculiarity of the hemorrhage, however, is in its causation by movements of the body of a jarring character, as riding over rough pavements, horseback exercise, and the like, or by manipulation of the kidney, and in its cessation afterward upon rest in bed.

In the presence of pyelitis the urine from the affected kidney may be acid or alkaline, and contains mucus, pus, and pavement epithelium, and generally casts, which indicate the extension of the process to the tubules of the kidney or the coexistence of a chronic diffuse nephritis.

Suppression of urine may occur during the course of an attack of renal colic as the consequence of blocking of the ureter of the affected kidney and reflex influences exercised upon the other kidney whose nature is not known, but which are probably due to acute congestion, just as happens after removal of one of the kidneys; under these circumstances the secretion of urine is usually resumed.

In other cases the suppression is caused by plugging of both the ureters at the same time by calculi, or of the only ureter if there is but one kidney: this condition is a dangerous one, and must surely result in death if the calculi do not pass or surgical interference is not practised.

It is interesting to note that patients have recovered after suppression extending over as long periods as twenty-one days;[1] but in general (71 per cent.) suppression ends in death within twenty-five days.[2]

Patients with suppression for any length of time develop the symptoms of chronic uremia and die in a typhoid state, emaciated with rapid and feeble heart action.

In the diarrheal discharges which accompany this condition, as well as in the sweat, considerable urea may be demonstrated.

In the first class of cases, those in which the stone enters only one ureter and becomes lodged, if the obstruction is incomplete hydronephrosis may follow; but this is rare. More commonly the obstruction is complete, and then atrophy of the corresponding kidney occurs.[3]

Pyelitis and pyelo-nephritis, or abscess of the kidney, are late complications of those calculi formed in aseptic kidneys—primary calculi; and the development of these diseases in persons already suffering from calculi is indicated by the appearance and persistence of pus in the urine. At the same time pain increases, and, as a rule, the kidney, distended by pus, may be recognized by palpation.

A febrile movement of a septic type is present, with evening exacerbations and morning remissions, and the patient begins to lose flesh and strength.

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[1] Delafield: *Lectures on Practice of Medicine.*

[2] Legneu: *Thèse de Paris.*

[3] Delafield: *loc. cit.*

The renal abscess thus formed may pursue the course described under the title of Pyonephrosis, and rupture into any of the contiguous cavities or externally, forming fistulous tracts whose tendency is to persist indefinitely.

The **diagnosis** of renal calculi is occasionally of some difficulty, especially early, before infection has occurred and there is no demonstrable enlargement of the kidney. The pain which calculi cause has sometimes simulated the pain of biliary calculi, of Pott's disease, of lumbago, or of some other disease of the kidney, especially nephralgia (*q. v.*). Bleeding may come from any part of the urinary tract.

The enlargement of the kidney after infection occurs may readily simulate enlargement of the kidney from any other cause.

Suppression of urine may also be due to a variety of causes, which must be excluded before one can be certain that calculi exist in the case in hand.

In a moderate number of cases the diagnosis can only be made after exposure and examination of the kidney through an exploratory incision.

Prognosis.—The existence of a calculus in an aseptic kidney is in itself of no very great moment: it is rather through secondary phenomena that renal calculi threaten life or produce suffering; for it would seem that the chronic diffuse nephritis which so usually accompanies the development of renal calculi is only another result of the gouty or other diathesis, which is also at the bottom of the stone-formation.

Renal colic is commonly recovered from, and if the calculus afterward escapes from the body, a spontaneous cure may be said to have occurred.

Infection of the kidney is far more grave, and not only increases the patient's suffering, but may cause death by chronic sepsis or by invasion of one of the neighboring cavities; but the process is ordinarily a slow one, and may persist for several years without seriously affecting the general health.

Suppression of urine of course is the most dangerous complication, and in particular that form due to plugging of both ureters at the same time: the temporary reflex suppression subsides spontaneously, but the obstructive type is regularly fatal.

Treatment.—In discussing the treatment of renal calculi one should refer to the management of the gouty diathesis with the view of preventing the formation of calculi, as well as the immediate treatment of the calculi already formed and the various complications to which they give rise.

The conditions under which calculi are formed in the kidney will indicate the mode of life which the susceptible individual must adopt to avoid them.

Regular exercise must be taken, and an out-of-door life pursued as far as possible; tobacco and alcohol should be eschewed; the diet must be simple and restricted, particularly in the matter of nitrogenous foods, and should include the use of much water.

In this way not only is the tendency to calculus-formation diminished, but those other obscure ailments dependent upon the gouty diathesis are also materially modified.

But certain medicinal agents are often of value in supplementing the dietetic regimen, and of these those spring-waters which are more or less diuretic and feebly alkaline are the best: they must, however, be taken in quantity, for it would seem that the salts alone are not sufficient for the purpose unless accompanied by the ingestion of large volumes of water; and it is upon this basis that the lithia waters are of benefit, for none of them contain lithia in sufficient quantity to produce any effect if only small amounts of the water are drunk.

The salts of lithium are alleged to possess the property of facilitating the excretion of uric acid by forming easily soluble compounds with it, and for this reason they may be exhibited from time to time in addition to the waters above referred to.

Piperazin is another drug recently introduced, which is said to possess similar characteristics.

The treatment of persons with the disposition to form oxalate-of-lime calculi is based upon much the same principles, but in this class of cases particular attention must be directed to the nervous system and to the stomach.

Patients who are likely to have primary phosphatic calculi are those whose urine usually contains an excess of phosphates, which may depend upon the mode of life or upon disturbances of digestion, especially of the functions of the liver; and in any case precipitation of these phospates is greatly favored by pyelitis, whatever its cause may be, by alkalinity of the urine, and by concentration of the urine.

In such cases the general hygienic treatment is about that for gouty individuals—out-of-door life, exercise, and temperance in matters of food and drink. In addition, digestive derangements must be corrected, and for this purpose Carlsbad salts, the mineral acids, etc. are of signal service.

The treatment of renal colic consists in relieving the extreme pain and in promoting the passage of the stone through the ureter. For the pain morphine in large doses, hypodermically, is indicated, but occasionally even this does not suffice, and under these circumstances one is obliged to administer ether or chloroform, but, as a rule, not up to the point of complete anesthesia; or both morphine and ether may be used.

The use of prolonged hot baths is of service in many cases, and appears to relieve the pain somewhat and to favor the passage of the calculus.

It is also conventional to encourage the patient to drink large quantities of water during the attack; but this would seem of questionable value in any instance, even if vomiting were absent, for the accumulated urine dammed back in the pelvis of the kidney probably very soon exerts enough pressure to prevent any further secretion from the tufts.

Suppression of Urine.—The management of suppression of urine during a renal colic depends upon whether it is due to reflex influences or to the synchronous plugging of both ureters: the first form will usually subside as the colic diminishes, and requires no special treatment, but the obstructive type is fatal unless the stones traverse the ureters within a reasonable period; so that every effort must be made to hasten their passage. But interference should not be long delayed, nor should one postpone relief too long because some doubt as to diagnosis may exist, nor should one temporize by opening the bladder to discover the condition of the ureters.

The kidney and ureter in which the colic began should be explored through a lumbar incision, and, if the calculus is accessible, it should be removed, together with any others present, or adequate provision made for the escape of urine.

The treatment of calculi existing in the kidney without giving symptoms, or even when there are occasional attacks of pain and hematuria, had best be directed to attempts to prevent the formation of more calculi by regulation of diet and mode of life; for the disability suffered by the patient is hardly enough to warrant surgical interference, though the decision of this question may very properly be submitted to the patient himself.

If, however, inflammation of the kidney or its pelvis develops, or the patient suffers from frequently repeated attacks of renal colic, or the pain is severe and intolerable, nephrolithotomy must be done. This operation, really a variety of nephrotomy, and originally signifying the removal of a concretion from a kidney otherwise practically sound, is employed also for the removal of calculi from kidneys the site of suppuration, and is described among the Operations upon the Kidney.

It is desirable at this place, however, to discuss some of the details of the operation peculiar to individual cases, and to quote some of the statistics of results obtained.

The removal of calculi from an aseptic kidney is carried out as described under the title of Nephrolithotomy in general terms—viz. exposure of the kidney, exploration of the kidney by palpation, acupuncture or incision of the convex border, extraction of the stone, and possibly closure of the incision of the kidney by suture.

The question sometimes arises, in case the kidney is found to contain a multitude of calculi and to be very extensively changed, whether to perform nephrectomy or not.

It would seem the part of prudence not to perform an immediate extirpation of the kidney; for in no inconsiderable proportion of cases both kidneys contain calculi, so that disaster might result if the entire work of the kidney were thrown on to one of them suddenly, and that one possibly also more or less diseased; again, every bit of kidney-tissue is of value, and by leaving this behind the performance of the functions of the kidneys is so much facilitated.

On the other hand, if a urinary fistula persists and the urine escaping into the bladder from the other kidney is of fair quality, a secondary nephrectomy may be very properly done.

The removal of calculi from suppurating kidneys ceases to be an operation performed solely for the extraction of the stones, but is rather done to supplement drainage, and is therefore described under Nephrotomy. The actual extraction of concretions under these circumstances is apt to be an undertaking of some difficulty, for the stones are usually soft and friable and accompanied by a good deal of detritus, and to occur in numerous pockets. Nevertheless, patient search of the pockets and the use of forceps and scoops, with free irrigation, will in the end serve to clear out the kidney entirely.

The question of primary nephrectomy sometimes comes up for decision here also, but in the writer's judgment should not be done, and only practised as a secondary expedient.

The removal of calculi from aseptic kidneys is done either by incision of the pelvis or of the kidney, and, so far as its mortality is concerned, is a safe operation. Among 40 cases collected by Legneu[1] there were but 3 deaths, and Newmann[2] found no deaths among a group of 42 cases.

The difference in results between operations done by incising the kidney-substance and those done by incising the pelvis is quite marked; Tuffier[3] arranges them thus:

Nephrolithotomy, 43 cases:	Mortality (operative)	6.1	per cent.
	Fistulæ	3.33	"
Pyelotomy, 12 cases:	Mortality (operative)	16⅔	"
	Fistulæ	20	"

These figures are probably more or less misleading, unless one considers that the great majority of these nephrolithotomies were performed before the idea of entering the pelvis of the kidney through the convex border became generalized, and that they therefore represent those cases of small stones imbedded in the parenchyma and removed by direct incision.

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[1] Legneu: *loc. cit.*

[2] Newmann: *Surg. Dis. of the Kid.*, p. 285.

[3] Tuffier: *Traité de Chir.*, Duplay et Reclus, v. vii. p. 516.

The removal of calculi from suppurative kidneys has not been so successful an operation; thus, of 114 cases analyzed by Tuffier,[1] 38 died, arranged as follows:

Nephrotomies, 114	Cured, 76 = 66⅓ per cent.	Complete, 50 = 43.8 per cent.,	Nephrectomy, 8; cures, 8. Curetting, etc., 1; cures, 1. Untreated, 17; deaths, 4.	
		Fistulæ, 26 = 34.2 per cent.,		
	Deaths, 38 = 33⅓ per cent.	Cancer of operated kidney		4
		Septicemia		3
		Peritonitis		2
		Tuberculosis of lungs		1
		Pneumonia		2
		Cachexia		1
		Nephritis		4
		Calculus of other kidney		9
		No autopsy		12
				38

HYDRONEPHROSIS.

Distention of the pelvis and calyces of the kidney by urine is called hydronephrosis: it differs from pyonephrosis in that in the latter the kidney is distended by urine in which more or less pus is present, and in its etiology.

It is possible for hydronephrosis to become pyonephrosis, but recently the term "infected hydronephrosis" has been introduced, and seems to express the natural history of the change and to leave the terms hydronephosis and pyonephrosis to be applied to conditions quite distinct.

Lesions.—The congenital type of hydronephrosis has been described under Malformations of the Kidney.

In the acquired form the pelvis of the kidney may be dilated, along with its calyces, without any very great change in the gland itself. In more severe cases the kidney is also involved, and the resulting change varies from simple flattening of the papillæ to almost complete disappearance of the cortex of the kidney; but even in the mildest cases the kidney is finally apt to show the changes of chronic diffuse nephritis. The resulting tumor may sometimes reach great size, containing many quarts of fluid and occupying almost the whole abdomen.[2]

In rare instances of kidneys provided with two ureters one has become obstructed, and half the kidney has been the site of hydronephrosis, and the same thing has happened in fusion of the kidney; but these curiosities have little or no practical significance.

The fluid distending the sac should consist of normal urine, but, as a matter of fact, and especially after the condition has existed for some time, the fluid contains a very small percentage of urea, and later this may entirely disappear and leave no evidence of the origin of the fluid; indeed, the fluid may be found to contain mucus and to be of brownish color, or it may contain colloid material or cholesterin, and make the distinction between this condition and ovarian cyst one of great difficulty.

Hydronephrosis may involve one or both kidneys, and where unilateral the opposite kidney is apt to be hypertrophied.

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[1] Tuffier: *loc. cit.*

[2] Sutton: *Tumors, Innocent and Malignant*, p. 381.

Etiology.—Renal calculus is only rarely a cause of hydronephrosis, but a few cases have been reported in which repeated temporary obstructions of the ureter during renal colic have finally led to very appreciable changes in the pelvis and calyces of the kidney.

Most cases of unilateral hydronephrosis, however, are due to partial obstruction of the ureter by pressure from without; thus it is not rare to find dilatation of the pelvis of the kidney developing with carcinomatous or other tumors of the pelvic viscera; and in one instance the writer saw dilatation of the ureter and pelvis produced by adhesions due to salpingitis. The same effect is produced by tumors developing in the bladder itself and involving the mouth of the ureter.

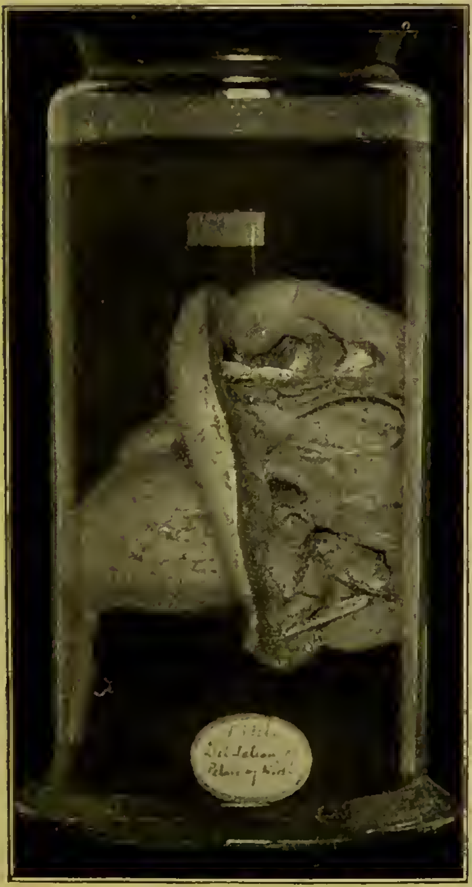

Fig. 202.—Hydronephrosis: dilatation of pelvis and calyces of kidney (Specimen 1346, Museum N. Y. Hosp.).

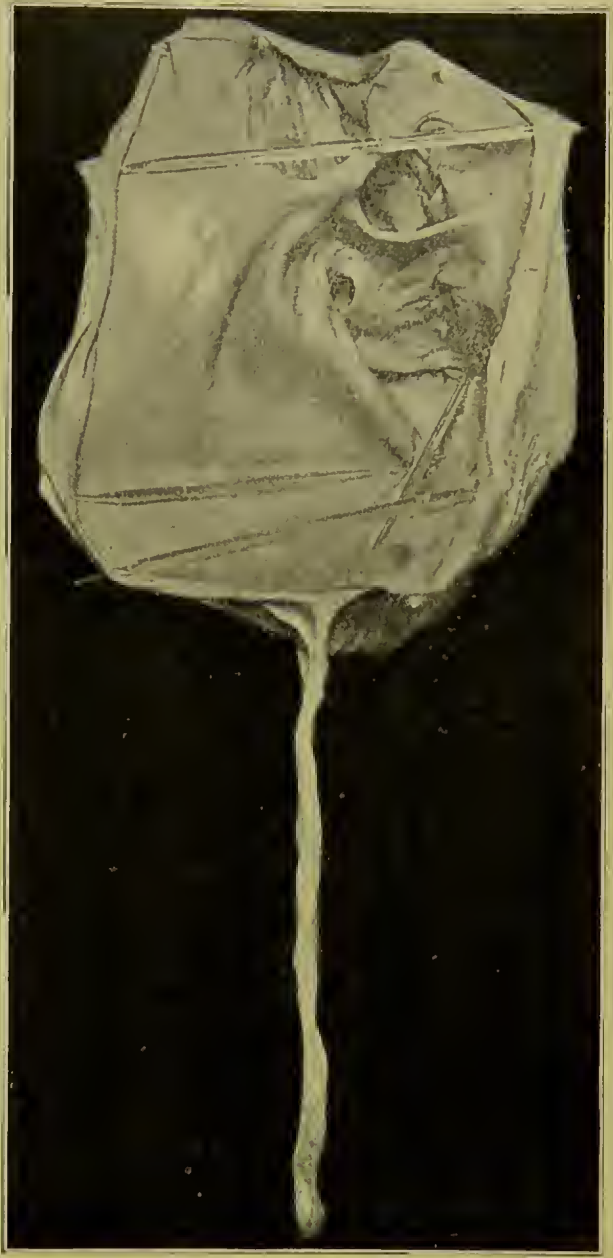

Fig. 203.—Hydronephrosis: kidney converted into sac (Specimen 3032, Museum N. Y. Hosp.).

Anomalies of the ureter also obstruct the escape of urine, as strictures due to ulcerations from any cause or kinking of the ureter in case of movable kidney, or there may be congenital obliteration of one of the ureters or the ureter may join the pelvis of the kidney at an acute angle and form a valve. For fuller details the reader is referred to the section on Diseases of the Ureter.

Bilateral dilatation of the pelvis of the kidney may be due to any of the conditions before mentioned acting on both ureters, but more often is caused by obstructions of the urethra, as phimosis, congenital or acquired stricture, or absence of the urethra, or enlargement of the prostate.

Symptoms.—Moderate unilateral dilatation of the pelvis of the kidney may give no symptoms at all, and is found at autopsy in persons who have died of other diseases; thus in an autopsy upon the body of a woman who had died of intestinal obstruction by a band due to old pelvic peritonitis, dilatation of the right ureter and pelvis of the kidney of moderate size was found, and, so far as could be learned, there had been no symptoms referred to the kidney during life.

But in those cases in which the hydronephrosis reaches a higher degree of development the existence of the tumor becomes the chief complaint; indeed, in many cases the only thing which the patient observes is the enlargement of the abdomen. The **diagnosis** then depends upon the recognition of the renal origin of the tumor.

These tumors, unless very large, occupy one or other of the lateral regions of the abdomen: they are usually smooth in outline; more rarely they are lobulated; there may be a misleading degree of mobility; in most instances the colon lies in front of the mass; fluctuation is usually easy to make out; finally, the introduction of the exploring needle and the examination of the fluid withdrawn will not only identify the character of the cyst, but will serve to distinguish it from pyonephrosis, which it most closely resembles.

The tumor with which hydronephrosis is most apt to be confounded is cyst of the ovary; and here, particularly if the latter happens to be fixed, it is sometimes impossible to differentiate without the aid of an exploratory incision.

In so-called intermittent hydronephrosis the symptoms are more characteristic. The tumor develops or increases in size quite rapidly; and this increase in size is accompanied by severe pain, simulating in many of its features renal colic, but never accompanied by the appearance of blood in the urine.

The urine then suddenly escapes from the pelvis of the kidney, and with this escape there is a well-marked increase in the quantity of urine passed, diminution in size of the tumor, and almost complete subsidence of pain.

Then the secretion of urine goes on regularly enough until some time when all the symptoms of obstruction redevelop: this occurs at greater or shorter intervals, varying in different individuals, and not infrequently at tolerably regular periods.

It is possible for the pelvis of the distended kidney to become infected from one source or another, becoming an "infected hydronephrosis." Under these circumstances the increase in pain, the appearance of pus in the urine, and the development of fever will indicate pretty clearly what is going on.

The recognition of the cause of the distention of the kidney is always of great importance in determining the treatment; for if the cause be a removable one, the treatment to be carried out is obviously to relieve the hydronephrosis by removing its cause.

Prognosis.—Hydronephrosis may exist indefinitely without endangering life, and may only affect health by its interference with the functions of the neighboring organs.

The tendency of the tumor is to increase in size, though it is said that occasionally it has gradually disappeared and spontaneous cure occurred.

The danger lies in the possibility of infection in the unilateral form, and, in addition, in the bilateral form, of uremia.

Treatment.—The treatment of hydronephrosis depends in great measure upon its etiology, and further upon the involvement of one or of both kidneys.

If the distention is due to partial obstruction of the ureter by an impacted calculus, to compression of the ureter by a tumor or inflammatory deposit, or to kinking of the ureter as in movable kidney, the treatment of the hydronephrosis would consist in relieving the obstruction by removing its cause, by extracting the stone through an incision of the ureter, by extirpating the tumor, or by suturing the movable kidney in place.

If, on the other hand, no definite or removable cause can be discovered, the cyst itself must be attacked, and then the procedure will be decided by the implication of one kidney or of both. If one kidney only is involved, the fluid may be removed by aspiration, but this in most cases is only palliative.

Nephrotomy will certainly reduce the size of the tumor, but is almost invariably followed by a fistula, which continues to secrete indefinitely, and is a source of almost as much annoyance as the original tumor itself, and generally requires a secondary nephrectomy for its cure.

Nephrotomy, however, as a preliminary to extirpation of the kidney has a distinct place, and, especially in case of very large tumors, is of no small value; for by drainage, continued for even a short time, the sac shrinks so much that it may then be removed, with decidedly less laceration of the surrounding tissues, through a smaller wound of the abdominal wall, and especially because nephrectomy may then be done through the loin; whereas to remove the distended sac would require opening the peritoneum. Nor would aspiration of the sac through an incision in the loin and its immediate removal answer as well; for even then a much larger raw surface would be left behind than if the extirpation was postponed till shrinking of the sac had occurred; nor is shock so great under the latter conditions.

Further, nephrotomy may prove curative if the ureter is still permeable. If, however, the tumor is only of moderate size, and yet demands removal for some special reason, and the condition of the other kidney is not known with certainty, abdominal nephrectomy may be performed in order to search for the cause and remove it if possible, and to explore the condition of the opposite kidney.

Tuffier[1] analyzes 58 cases of nephrotomy and nephrectomy for hydronephrosis, as follows:

Nephrotomy:	Mortality	18.8	per cent.
	Fistulæ	66⅔	"
Nephrectomy:	Mortality	13.1	"
	Abdominal	25.8	"
	Lumbar	6.4	"
Secondary nephrectomy:	No deaths.		

TUMORS OF THE KIDNEY.

Both cysts and solid new-growths are included in the group of tumors.

I. **Cysts.**—Cysts of the kidney occur in one or other of several forms:

1. In kidneys otherwise normal there are one or more cysts filled with clear or brownish serum or colloid matter. These cysts vary in size from a walnut to considerable dimensions, and rarely may become very large; they arise in any part of the kidney, but occur most frequently in one or other of the poles. They are unilocular and smooth; the cyst-wall is delicate and transparent, and is continuous with the kidney-tissue; it consists of fibrous

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[1] *Loc. cit.*, p. 600.

tissue and is lined by flattened epithelium. In rare instances the wall may be thickened and infiltrated by the salts of lime.

2. In kidneys the sites of chronic diffuse nephritis, groups of tubes are dilated: such cysts are usually microscopic in size, and give no symptoms apart from the disease which they accompany, and are of only pathological interest.

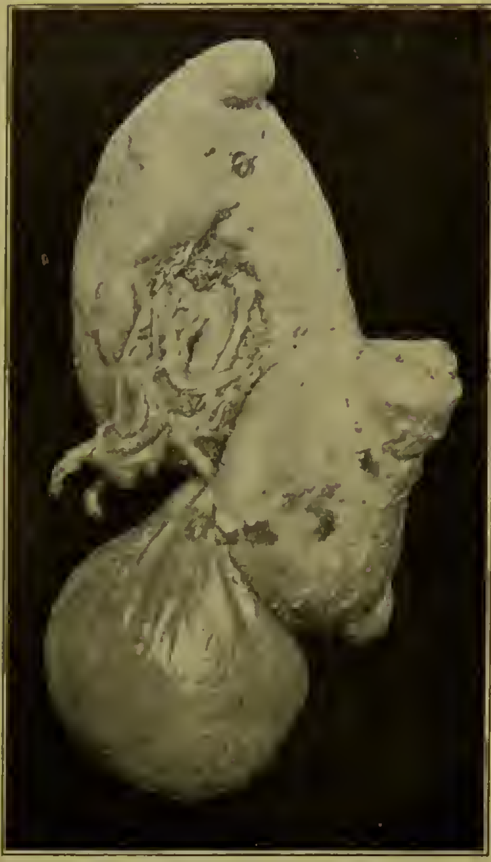
FIG. 204.—Serous cysts of kidney (Specimen 1577, Museum N. Y. Hosp.).

3. Both kidneys, or more rarely one, are much enlarged and converted into a mass of cysts containing clear or colored serum or colloid matter. The walls of the cysts, which are usually about the size of marbles, consist of connective tissue supporting a small amount of kidney-tissue, and are lined by pavement epithelium. The contained fluid holds urea in solution.

Kidneys thus changed are found in the fetus, at times associated with similar cysts in the liver or fetal malformation. In other instances the cysts are apparently retention-cysts due to obstruction of the tubules by uric-acid salts, or obliteration of these tubules by fetal inflammations, or atresia of the pelvis of the kidney or ureter, or to absence or stricture of the urethra.

In the adult such kidneys occur also, and may then be congenital and due to one or other of the above causes or exist without assignable cause.

4. Hydatid cysts are very rare in this country: they present the same anatomical features as elsewhere. One kidney only is affected as a rule, and the cyst may be located anywhere in the organ. Adhesions may form between the cyst and the neighboring viscera. The sac may rupture into the pelvis of the kidney, into the lung, or into the intestine.

Etiology.—Nothing very positive is known in regard to the development of the larger single cysts of the kidney. They occur in persons between the ages of twenty and forty-five years, and more often in females than in males; of 20 cases collected by Tuffier, but 3 were in males.

The causation of the large multicystic kidneys is equally obscure: it is perhaps congenital. The condition is found more often in males than in females.

The etiology of the hydatid cysts is self-evident.

Symptoms.—The minute cysts of chronic diffuse nephritis give no symptoms apart from the lesion with which they occur.

The larger single serous cysts, the "cystic kidney" and hydatid cysts, give no other symptoms, as a rule, than the appearance of the abdominal tumor and the interference with the function of the neighboring viscera to which it may give rise.

The exception to this statement is the "cystic kidney," which sometimes gives the clinical history of chronic diffuse nephritis with little or no exudation—namely, lowering of the specific gravity of the urine and the presence of a trace of albumin from time to time, and later attacks of uremia.

The **diagnosis**, then, depends upon the identification of the tumor in hand.

The single cyst occurs most often in women; it is usually unilateral; its surface is smooth and fluctuation distinct; it is connected with the kidney. The exploring needle will often, though not always, serve to distinguish the condition by the character of the fluid evacuated.

The tumor formed by the hydatid cyst is generally smooth, situated in the flank, and gives the signs of renal tumor. In consistency it varies from the characteristics of fluid to those of a solid neoplasm; but in either case the so-called hydatid fremitus should be elicited upon percussion. The exploring needle withdraws fluid containing scolices.

If the cyst ruptures into the pelvis of the kidney, the patient suffers from renal colic and evacuates fluid containing the hooklets; rupture into the intestine or lung may occur and give symptoms indicative of the character of the accident and the nature of the tumor in each case.

The large "cystic kidney" is almost always bilateral, so that in a patient giving a history of chronic diffuse nephritis, if the kidneys are at all enlarged, and particularly if their surfaces are nodulated, one must think of cystic kidneys.

Prognosis.—In all of these conditions the cysts are of very gradual growth, and, except in the case of the hydatid and the single cysts, the danger to health and life lies in the associated chronic diffuse nephritis.

In the single serous cysts the only damage likely to be done is through compression of, and interference with, the function of neighboring organs. Hydatid cysts also produce pressure-symptoms, but they are dangerous to life in that rupture in one or other direction may be fatal, or through suppuration.

Treatment.—For the minute cysts of chronic diffuse nephritis, and for the large multicystic kidneys, there is no treatment other than that of the symptoms of the nephritis.

The single serous cysts, however, if they are large enough to give symptoms, demand interference either by aspiration, drainage, or partial or complete nephrectomy.

Aspiration is not to be recommended except as a palliative measure, for in nearly every case in which it has been attempted the sac has refilled.

Incision and drainage is the procedure of choice, for several reasons: The operation is sometimes curative, though in the majority of the cases fistulæ persist; but in the event of fistula a secondary nephrectomy may be performed.

In case, for any reason, nephrectomy, partial or complete, is decided upon, it may very well be preceded by drainage with the view of reducing the size of the sac, and thus not only facilitating nephrectomy, but making a very extensive wound unnecessary.

But primary nephrectomy has often been performed for this condition, and with fair success. Tuffier[1] has collected 31 cases; and of these 7 were lumbar, with a mortality of 11 per cent.; 24 were transperitoneal, with a mortality of 46 per cent., divided as follows: peritonitis, 2; purulent infection, 2; hemorrhage, 1; collapse, 1; nephritis of remaining kidney, 1; not stated, 4.

Complete nephrectomy has usually been done, but Tuffier[2] advises partial nephrectomy as a decidedly more preferable measure where any considerable part of the kidney remains unaffected.

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[1] Tuffier: *Traité de Chir.*, Duplay and Reclus, vol. vii. p. 581.

[2] *Loc. cit.*

Hydatid cysts are to be treated as they are in the liver, by incision and drainage, preferably through the loin.

II. The **new growths** of the kidney may be arranged upon an anatomical basis or from a clinical standpoint, and divided into *malignant* and *benign* tumors; and of these latter groups the first is vastly commoner than the second, and also of more significance both to the physician and the patient.

The *malignant tumors* in the kidney, as elsewhere, are those prone to local recurrence and to generalization—the carcinomata and the sarcomata.

By some writers the carcinomata are included among the adenomata, and *vice versâ;* but, although the transition from adenoma to carcinoma is often hard to define to the microscopist, the clinical behavior of the two classes is very distinct.

All the varieties of carcinoma occur in the kidney as primary or secondary deposits, but most often the primary growth assumes the medullary type and is richly cellular. It arises generally in the cortex of the gland, either as a single encapsulated growth or may be infiltrating from the first; or a number of tumors may develop in different parts of the kidney at the same time.

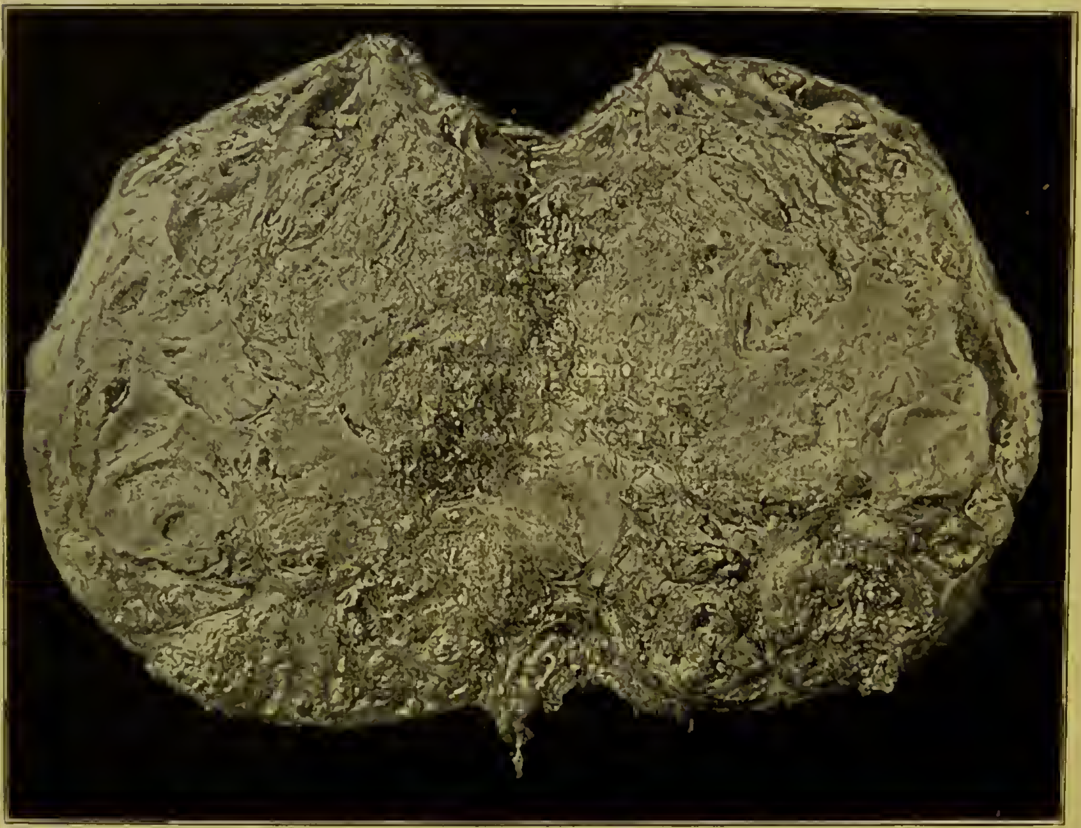

FIG. 205.—Author's case of renal sarcoma (Sutton), adenoma (Delafield and Prudden), carcinoma (Lubarsch). Tumor composed of adrenal tissue.

In size the tumors vary inversely with their numbers, so that as many as twenty may be found in a single kidney, each of small size, or in other cases a single tumor may be present and reach the dimensions of a man's head or larger. In either case the affected kidney is enlarged, and may be nodular or smooth in outline.

Occasionally parts of the tumor are found to have undergone retrograde changes and to be replaced by fluid material, generally gelatinous.

The origin of the new epithelium is disputed, and perhaps varies in different cases; but the trend of opinion seems to lean toward the cells of the tubules as the source of the growth.

The tumor may spread to the pelvis of the kidney, and give rise thus to more or less bleeding; or masses of greater or less size may separate from the tumor and escape with the urine.

The renal vein or the vena cava may be involved in the growth, and thus convey secondary deposits to the lungs.

The lymph-vessels and glands at the hilus may be implicated, and form tumors large enough to compress the vena cava or the ureter.

The surrounding structures may be involved by contiguity; thus the peritoneum, the liver, the intestine, or the abdominal wall may be the site of carcinoma.

Cases have been reported in which carcinoma of the kidney was complicated by hydronephrosis, by renal calculus, or by nephritis.

It is only necessary to mention the secondary carcinomata occurring in the kidney, for they possess no surgical interest and are not amenable to treatment.

Etiology.—Primary carcinoma of the kidney is rare compared with similar growths of other tissues: it occurs more often in men than in women, and most often between the ages of fifty and seventy years.

The right kidney is the site of the tumor oftener than the left, and least often both kidneys are attacked at about the same time.

Secondary carcinoma of course is conveyed to the kidney from some other part of the body by the blood in the shape of emboli.

Sarcomata, like carcinomata, occur in the kidney as primary and as secondary growths, and, like carcinomata also, the primary growths alone are of interest to the surgeon from the standpoint of treatment, inasmuch as the secondary deposits usually occur in both kidneys, while in the case of primary sarcoma one kidney only is affected, as a rule.

Both round and spindle-celled sarcomata are found in the kidney as primary growths, and not infrequently in combination with each other or with other forms of sarcoma.

In some of the cases reported muscle-fibers have been found in the tumors, and their presence is explained on the ground of fetal inclusions.

Sarcoma occasionally is blended with carcinoma or with adenoma.

The kidney-tissue is generally destroyed by the infiltration of the sarcomatous tissue, but occasionally foci of glomeruli and tubules are found in the new growth itself.

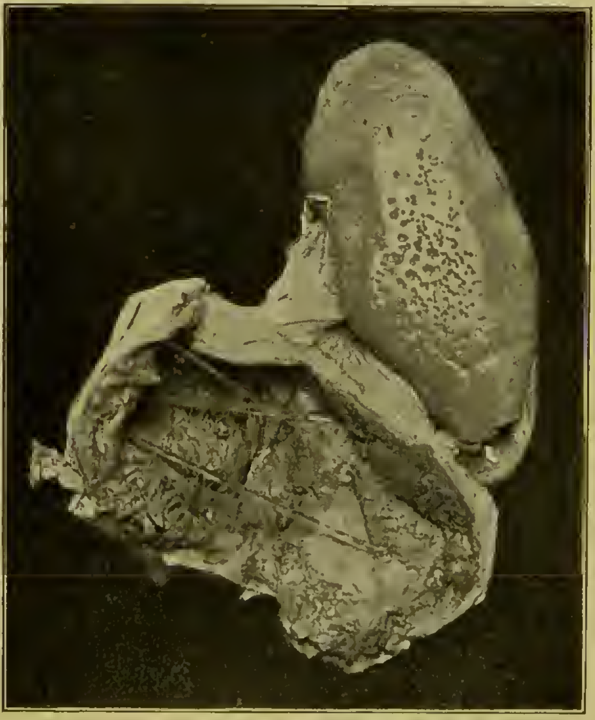

FIG. 206.—Sarcoma of kidney (Specimen 2019, Museum N. Y. Hosp.).

The effect of sarcoma upon the gross appearance of the kidney is to convert it into a mass of variable size, which may be irregular in shape, but which not infrequently conforms more or less closely to the outline of the kidney. The tumor may reach great size; it is generally lobulated or nodular.

The mass, if it reaches any size, almost always contains one or more cysts, the effect of hemorrhage into the substance of the tumor.

Secondary growths appear most often in the lungs, and less frequently in other parts of the body.

The exact causation of sarcoma is as little known as that of carcinoma. This form of tumor occurs oftenest in children between birth and the age of six years; next between forty and sixty years; and least frequently between six and twenty years.

Of 24 cases collated by Rosenstein,[1] the left kidney was the site of the tumor in 14; the right in 8; both in 2.

Females are oftener attacked than males.

Symptoms.—Malignant tumors, whether carcinomata or sarcomata, give about the same symptoms, and hence it is convenient to describe them together: they may be arranged as the tumor, pain, hematuria, cachexia, combined or occurring separately.

The tumor only attracts attention on account of its size after it reaches some proportions; it may reach considerable dimensions, but usually is not very large.

The symmetry of the abdomen is not disturbed, except in those cases in which the tumor attains great size or the abdominal walls are very thin and retracted.

In any case the tumor arises in the flank and may retain the outlines of the kidney, or the shape of the mass may become irregular, particularly after adhesions to other organs have occurred.

The surface of the growth may be smooth or lobulated; its consistency varies, but is usually elastic or even semi-fluctuating. Mobility is sometimes marked, and especially as the effect of respiration.

Pain is referred to the region of the affected kidney, but is not constant; in other cases pain is severe, and occasionally occurs in attacks simulating renal colic. These attacks of colic are likely to occur in those patients in whom bleeding and the separation of pieces of the tumor are prominent features, and then are due to the passage of clots or of tumor-masses through the ureter.

Hematuria is present in about half[2] the cases at some period in their courses. Tuffier[3] says that this symptom occurs in three-quarters of the cancers, one-half of the sarcomata.

It may appear early or late in the disease, or reappear at intervals of days or weeks. The amount of blood varies from quantities so small as only to be detected by the microscope to profuse hemorrhages dangerous to life.

Bleeding in tumors of the kidney differs from that of calculi in that the former is spontaneous, and is little or not at all influenced in its production by jarring or in its subsidence by rest, while in the latter the reverse happens.

What is characteristic of bleeding from the kidney, and oftentimes serves to identify the source of the blood, is the appearance in the urine of clots of long, slender shape, formed by coagulation in the ureter and forming accurate casts of this canal.

Loss of flesh and strength, cachexia, is sometimes long deferred in tumors of the kidney, but develops sooner or later, and with it there are often symptoms of interference with the function of the organs of digestion.

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[1] *Loc. cit.*, p. 391.

[2] Delafield: *loc. cit.*

[3] Tuffier: *op. cit.*, p. 606.

Prognosis.—It is a singular fact that patients suffering with malignant diseases of the kidney often survive for periods far greater than those suffering with similar diseases of other viscera; but they are inevitably fatal, in the case of adults, in from three to five years, and in infants much sooner.

Death may be due to generalization, to cachexia, to repeated hemorrhages, or to implication of the large veins and pulmonary embolism.

Treatment.—The only method of treatment likely to prove curative here, as elsewhere, is extirpation performed according to the rules governing the removal of malignant tumors from any part of the body—namely, early and thorough extirpation.

Nephrectomy for tumors may be done either through the loin, or the route to the kidney may be transperitoneal, and the excision may be total or partial.[1]

The lumbar route should be used where possible, and the abdominal operation chosen only for those cases not suited for the operation in the loin, as indicated in the description of Nephrectomy (*q. v.*).

But the fact that statistics show the lumbar operation to be less fatal should not determine its choice for every case, for tumors of the kidney occur that are of such size and connections that removal by the loin is impossible; or, in other cases, renal tumors may simulate tumors of other abdominal organs so closely that the diagnosis can only be made by an exploratory incision.

The mortality is high in any case, and recurrences frequent: Chevalier[2] gives the figure as 62.5 per cent. for all cases. Siegrist, quoted by Tuffier, gives 57 per cent. as the mortality of abdominal and 25 per cent. as the mortality of lumbar nephrectomy; but recurrence is more common after lumbar nephrectomy (41 per cent.) than after the abdominal operation (5.26 per cent.).

Partial nephrectomy will prove very rarely practicable, and can only be done in those rare cases, as Abbe's, in which the growth probably originates in the capsule and simply crowds the kidney tissue before it.

Operations for malignant disease of the kidney, so far, have not given much reason for encouragement: the mortality is high, recurrence is very common. But it would seem as though here, as elsewhere, early operation would afford better results than those indicated by the present statistics.

The **benign tumors** of the kidney include adenoma, lipoma, and fibroma of the gland itself, and papilloma of the pelvis.

The *adenomata* are usually of small size, encapsulated, situated in the kidney substance, and occur singly or there may be several in each kidney.

In structure the adenomata approach the carcinomata very closely at times, and indeed by some writers no attempt is made to distinguish one from the other; but clinically, at least, the natural history of the two tumors is certainly distinct; The tumors are limited by a capsule of connective tissue, within which the epithelial cells are arranged to simulate roughly the appearance of the tubules.

The *fibromata* are also found in the kidney substance occasionally, associated with chronic diffuse nephritis. In structure they consist of fibrous tissue enclosed by a capsule; they are ordinarily of small size.

The *lipomata* which occur in the kidney are usually of small size and of only pathological interest.

Besides these forms of benign tumors, mention must be made of myxomata, angiomata, lymphangiomata, gliomata.

Papilloma of the pelvis of the kidney presents the characters of papilloma of the bladder, and indeed they may coexist.[1] The tumor is usually pedunculated, dendritic, of variable size, and consists of a fibrous stroma overlaid by epithelium.

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[1] Abbe: *Ann. of Surg.*, Jan., 1894.

[2] Chevalier: *Thèse de Paris*, 1891.

The symptoms of benign tumors, owing to their small size and trifling interference with function, are exceedingly obscure and are seldom recognized.

Occasionally it has happened that the tumor has reached some size, and then has been detected and submitted to treatment either by partial or total nephrectomy.

Tumors of the kidney capsules, fibrous or fatty, are sometimes separately described in systematic treatises upon the kidney, but lack of space will prevent more than mentioning the fact in this place that from the fibrous capsule fibromata, sarcomata, and fibro-sarcomata may arise, and from the fatty capsule lipomata, myxo-lipomata, fibro-lipomata, and myxo-sarcomata.

The whole number of such cases so far reported is not large, and the natural history of such tumors is, therefore, but imperfectly known.

Their peculiarity appears to consist in the fact that, however great the tumor may become, and they reach great size, the kidney remains practically unchanged. But, unfortunately, it has been found impracticable in most of the cases reported to preserve the kidney when the tumor was submitted to extirpation.

MOVABLE KIDNEY.

Under a variety of circumstances it is possible for the normal range of motion of the kidney to be increased; but the title of movable kidney has now been restricted to a condition of the kidney in which its abnormal mobility is due to causes other than displacement by tumors of other abdominal organs or as the effect of tumors of the kidney itself.

The term "floating kidney" is commonly used as synonymous with "movable kidney," but, for accuracy's sake, should be confined to those exceedingly rare states in which the kidney is actually surrounded by peritoneum and suspended in the abdominal cavity by a distinct mesonephron.

Lesions.—According to Morris, the fatty capsule which normally invests the kidney snugly may be of lax texture and allow the kidney to move within it; or the attachment of the fatty capsule to surrounding parts, and especially to the peritoneum, may be so slack that both the kidney and its capsule move freely behind the peritoneum; in either case fat is less abundant in the capsule than usual.

The kidney itself, excluding those cases in which disease of the organ is the cause of mobility, is usually normal, or, more rarely, there may be a certain degree of dilatation due to repeated distentions by urine retained as the result of kinking of the ureter.

The vessels entering the hilus are often elongated to a surprising degree.

Associated with movable kidney it is not rare to find enteroptosis, or, at any rate, dilatation of the stomach and chronic gastritis; and it would seem that at least in a certain proportion of cases the mobility of the kidney was secondary to the first condition, especially when the movable kidney happens to be the left one.[2]

Dilatation of the gall-bladder is occasionally combined with mobility of the right kidney, and is probably due to obstruction of the common duct produced by the kidney's dragging on the descending duodenum.

Etiology.—Movable kidney occurs at all ages and in both sexes, but more often in women than in men in the proportion of 7 to 1,[1] and between the ages of twenty-five and forty years.[2] The right side is more frequently affected than the left—least often, both.

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[1] Murchison: *Trans. Path. Soc.*, vol. xxi. p. 241.

[2] Tuffier: *Congrès de Chir.*, 1889 and 1891.

As to the absolute frequency of movable kidneys opinions vary widely: pathologists place the proportion much too low, while clinicians in search of movable kidneys discover them with astonishing regularity.

Morris, quoting Skorckewsky, fixes the ratio at 32 among 1422 patients, or about 1 in 44.

The fact that abnormal mobility of the kidney develops most frequently in women who have borne children at short intervals, and particularly in those whose circumstances have obliged them to resume severe manual labor shortly after parturition, has pointed out the chief causes of movable kidney—namely, disappearance of the perirenal fat, prolonged expulsive efforts, and the rather sudden diminution of intra-abdominal pressure.

The effect of diminution of fat is to withdraw at least one of the agents by which the kidney is retained in place, and to throw the support of the kidney upon its vessels and the adhesions which exist between it and the peritoneum in front and the transversalis fascia behind.

If under these circumstances prolonged expulsive efforts are made, and the kidneys thrust downward by the diaphragm acting directly upon the kidney on the left side and upon the kidney through the liver on the right side, the attachments of the kidney are stretched inordinately. If, now, the patient gets up and goes about, and especially if she performs manual labor, there is no opportunity for the attachments of the kidney to contract, as they would probably do if the kidney were allowed to remain in its natural position by recumbency of the patient. Thus the kidney is loosened, and remains so, not only because of the assumption of the upright position of the patient, but also because intra-abdominal pressure, greatly diminished by the evacuation of the uterus, allows the kidney to move freely behind the peritoneum and to bulge forward into the abdominal cavity.

Mobility of the kidney occurring with enteroptosis—displacement of most of the abdominal organs downward—owes its development to the same condition that has resulted in dislocation of the other organs, and whose causation is as yet not fully understood.

The origin of movable kidney has occasionally been traced to injury—either direct injury of the kidney region or to displacement by falls upon the feet or buttocks.

The influence of tight lacing upon the kidney is often referred to as a cause of mobility of the organ, but whether it has this effect or not cannot be decided with precision. Most women are in the habit of constricting the abdomen and lower chest, but comparatively few have movable kidneys; and it is in just the class who do not lace tightly that movable kidney occurs with greatest frequency—namely, women of the working classes.

Symptoms.—With some movable kidneys there are no symptoms at all, or only very slight pain, referred to the loin of the affected side. In other cases, however, the symptoms are well marked and often most distressing: they may begin suddenly or more gradually, but when established there are usually three sets of symptoms besides the existence of the tumor.

The pain is most often of a dull, dragging character, felt in the back and referred to the affected side; it is sometimes severe, and may be aggravated by changes of position or by effort.

At intervals, which are sometimes variable or which recur at regular periods, the patient suffers from attacks of pain simulating renal colic very closely. These attacks are precipitated by a variety of causes, as fatigue, etc. The pain is exceedingly severe, and may radiate from the loin to the epigastrium, to the intercostal spaces, to the shoulder, down the ureter to the testicle, labium majus, or thigh. There are usually nausea and vomiting, and the abdomen may be distended and tender. There may be a slight rise in temperature.

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[1] Newmann: *Surg. Dis. of Kidneys.*

[2] Delafield: *Lectures on Practice.*

Micturition is increased in frequency, and may be accompanied by urgency and tenesmus, but there is very rarely or never blood. As the crisis subsides there may be marked increase in the quantity of urine evacuated, and it is apt to be pale and of low specific gravity.

These attacks correspond quite accurately to the symptomatology of intermittent hydronephrosis; and that this is their true character in many cases the recognition of enlargement of the kidney during the attack will attest; in others, however, the facts do not harmonize so well, and then the pain is said to be neuralgic.

Disturbances of the function of the alimentary canal are very frequently associated with movable kidney, and are especially marked in those cases combined with enteroptosis or with gastric dilatation; thus the patient may suffer from gastric and intestinal indigestion, from constipation, etc.

If this disturbance of the stomach were due alone to pressure upon the duodenum, such symptoms should be absent if it happens to be the left kidney which is movable; but dyspepsia is also present in this condition, so that some other explanation must be sought.

Patients with movable kidneys suffer from a variety of nervous symptoms, conveniently called by the name "neurasthenia," which are often out of all proportion to the lesion present. Thus these patients may have areas of anesthesia, neuralgias of various kinds, and even hysterical seizures.

The tumor, upon the detection and recognition of which the diagnosis depends, is not always easy to discover or to identify, and it is often necessary to examine the abdomen several times before one is able to palpate the kidney at all.

The displaced kidney is usually found lying close behind the anterior abdominal wall, below the free border of the ribs; it is of firm consistency, rounded borders, and freely movable, and disappears in dorsal decubitus or may be reduced into the loin, and there gives renal ballottement, and reappears on the assumption of the erect position.

The tumor formed by a movable kidney must be differentiated from those of the pylorus, spleen, pancreas, ovary, mesentery, omentum, and from distention of the gall-bladder.

Prognosis.—While in the majority of cases movable kidney constitutes only a cause of more or less intense suffering, and does not threaten life, in other instances the general health is impaired, not alone by the repeated attacks of pain, but also by the disturbance of the functions of the stomach and bowel.

In those cases in which an intermitting hydronephrosis develops, a chronic diffuse nephritis may be set up, and the patient suffer from its symptoms.

Treatment.—In the mildest cases no other treatment is required than the avoidance of the over-exertion which causes the pain of which the patients complain.

In the more severe cases the problem to be solved is to devise a means of keeping the kidney in its place: this it is possible to do in either of two ways—by proper support or by suture; and of these means the former will naturally be tried first.

Support to the displaced kidney may be afforded by a variety of bandages, in all of which the essential parts consist of a pad held in place by a belt. The shape of the pad and its size vary a good deal with the size and configuration of the abdomen, but the belt in every case should be broad enough to take its support from the crests of the ilia.

The apparatus should be applied during recumbency, with the kidney in its normal position; it must be worn during the day, but at night may be discarded.

In those cases in which enteroptosis, rather than movable kidney, is the cause of the symptoms, firm support of the abdominal wall often gives very prompt relief; and it is in just this group of cases that support, and not operation, is indicated.

On the other hand, in those cases in which there is no special prolapse of the viscera, and in which pain, whether neuralgic or due to retention of urine by kinking of the ureter, is the chief symptom, nephrorrhaphy is indicated, and has given gratifying relief in many instances. Delvoie[1] has collected 363 cases, and analyzes but 215, as follows:

	Cures.	Improved.	Failure.	Relapse.	Death.
Suture of fatty capsule	4	3	2	5	0
Suture of fibrous capsule	10	3	4	5	2
Suture of parenchyma without stripping of capsule	75	14	11	8	2
Suture of parenchyma, after stripping capsule	9	0	1	0	0
Special methods	5	5	0	0	0
Operations of uncertain character	32	5	7	2	1
	135	30	25	20	5

Thus it appears that the mortality of nephrorrhaphy is very low, and that suture performed through the kidney substance after stripping the capsule is a fairly successful operation.

Extirpation of the movable kidney is rarely done, and then only after failure of all other means to control the pain.

NEPHRALGIA.

Under the caption of Nephralgia there have been grouped a considerable number of cases in which the patients suffered from pain referred to the kidney, and in whose kidneys no appreciable change existed,

The pain suffered by such patients is often severe, simulating renal colic in some instances, occurs in attacks like those due to renal calculus, and rarely has been accompanied by the appearance of blood in the urine.

The nature of the conditions giving rise to this pain are little known, and, indeed, are probably widely diversified.

In a certain proportion of cases the pain seems to be of reflex origin, and to be due to lesions of other parts of the genito-urinary tract, as the prostate, bladder, ureter, or the other kidney, or to lesions of more remote parts of the body, as the nervous system, intestine, etc.

In another group, on which Tiffany[2] lays particular stress, the lesion lies in the fibrous capsule of the organ.

In other cases the patients suffer a pure neuralgia, unaccompanied by any demonstrable change, and as obscure in its nature as similar conditions in other parts of the body: not a few of these cases have given the history of pre-existing malaria or syphilis or suffer from anemia.

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[1] *System of Surg.*, Dennis, vol. iii. p. 473.

[2] Tiffany: *Ann. Surg.*, 1889, p. 104.

The close resemblance of the symptoms of kidney neuralgia to those of other conditions of the kidney renders the diagnosis exceedingly difficult; indeed, in many of the cases reported operation was undertaken in the belief that a renal calculus was to be dealt with.

This similarity of symptoms becomes wellnigh indistinguishable when hematuria is added.

The kidney is often tender to pressure.

The indications for **treatment** of kidney neuralgia are almost unknown.

Relief from the attacks of pain has followed exploration of the kidney through the loin, with simple palpation or needling or incision, but in other cases no benefit has followed.

It would seem as though the possible causes of the neuralgia should be first attended to; thus cystitis, etc. should first be treated with the idea that the pain may be reflex and due to the obvious lesion.

If pain is not relieved in this way, then the kidney itself must be attacked by exposing it in the loin and splitting its capsule along the convex border. A considerable number of cases have been cured by this procedure, but others have not been improved at all.

In the latter instance nothing remains but nephrectomy, which should be performed by the extra-peritoneal method.

OPERATIONS.

The kidney is accessible for operative procedures through the posterior abdominal wall, by incisions in the loin or through the anterior abdominal wall; but, while in the former the peritoneum is never designedly wounded, in the latter the route to the kidney lies through the peritoneal cavity.

Of these methods there can be no question that the extra-peritoneal operation is less dangerous than the trans-peritoneal, for, notwithstanding that wounds of the peritoneum are far less dreaded than formerly, the possibility of peritonitis should make the lumbar operation preferable wherever no special contraindication exists.

Aside from nephorrhaphy, which is always done in the loin, and nephrotomy, also done here, many tumors even of some size may be removed by this route, for it is found that growths of the kidney push the reduplication of the peritoneum from the abdominal wall to the mesocolon forward, and thus increase materially the space possible for manipulations.

The form of the incision in the loin may be varied considerably to meet the particular requirements of the case in hand; but in any instance the patient is placed upon his sound side, with a pad of suitable size beneath the flank to separate the costal margin from the iliac crest of the affected side.

In some cases it will be found advantageous to place the patient in a semi-prone position or to have an assistant crowd the kidney toward the loin by pressure upon the anterior abdominal wall.

The vertical incision of Simon is made from the eleventh rib along the outer border of the erector spinæ muscle to the iliac crest; the subcutaneous fat and latissimus dorsi are divided to the same extent, and the quadratus exposed by dividing the middle layer of the transversalis fascia from the twelfth rib to the lower angle of the incision; its fibers are retracted toward the spine by blunt hooks, or the iliac portion of the muscle cut through close to the ileum, and the anterior layer of the transversalis fascia exposed with the ilio-inguinal and ilio-hypogastric nerves and some of the lumbar vessels: these structures are pushed to one side or cut, and the fascia split up when the fatty capsule comes into view.

By carefully tearing through the fatty capsule the kidney is exposed in the lower half of its posterior surface.

While this form of incision answers the purpose in many cases, in others it does not yield sufficient space for manipulation of the kidney, and hence various means have been employed from time to time to secure more room.

Resection of the twelfth, and even of the eleventh, rib has been performed in a few instances, but the danger of opening the pleura, together with the fact that retraction of the rib by blunt hooks is equally good, has led to the very general desertion of this plan and to the invention of modifications of the form of incision to afford more space.

The oblique incision, practised by Czerny, is made a finger's breadth below the twelfth rib and parallel to it, from the outer border of the erector spinæ downward and outward for a variable distance, depending upon the circumstances: when necessity requires this incision to be of considerable length, as the iliac crest is approached the incision should be curved and carried forward toward the umbilicus; the latissimus dorsi and the three flat muscles of the abdomen are divided to a variable extent, and the quadratus and anterior layer of the transversalis fascia treated as in the vertical incision to expose the kidney.

The incision devised by König, however, will be found most generally useful in almost all the lumbar operations upon the kidney, in that it yields the maximum working space and can be enlarged at will. It consists of division of the skin along the outer border of the erector spinæ from the twelfth rib to the level of the umbilicus, when the incision curves forward and may be prolonged to the umbilicus, and the peritoneal cavity opened if occasion requires; the quadratus and anterior layer of the transversalis fascia are exposed by dividing the latissimus dorsi and the flat muscles of the abdomen; the iliac portion of the quadratus is cut and the muscle retracted; the fascia is split, and the fatty capsule of the kidney comes into view, and also the line of reduplication of the peritoneum, which it is often of importance to locate accurately.

In closing this incision, as well as the Czerny incision, the divided muscles must be accurately united by suture to ensure restoration of function as well as to prevent hernia; and for this purpose some kind of absorbable material is much to be preferred, for even where primary union has occurred silkworm gut has often caused the formation of troublesome sinuses.

The wound of the skin may be sutured wholly or in part, or may be packed with gauze or drained by tube.

Operations upon the kidney conducted through the peritoneum by incisions of the anterior abdominal wall may sometimes be necessary, either for the removal of tumors too large for extraction by the lumbar route, or where doubt exists in regard to the presence or condition of the kidney not immediately concerned, or finally where the abdomen is opened in the belief that tumors of other organs are to be dealt with.

In the great majority of cases the peritoneum will only be opened for the removal of very large tumors.

The incision may be made in the linea alba or in the linea semilunaris, as advised by Langenbuch; and of the two positions, the lateral one is found most generally useful in providing access to the renal tumor, which is usually situated to one or other side of the median line, and in facilitating its separation from surrounding parts, particularly the colon, which must always be pushed inward.

The incision is made through the linea semilunaris from the costal cartilages downward to as near Poupart's ligament as may be necessary, and in some cases of very large tumor a second incision, carried outward from the first in a horizontal direction to a variable extent, may be made.[1]

The bleeding from the thinned abdominal wall in this extensive wound is ordinarily inconsiderable, but should be stopped entirely before the peritoneum is opened.

After entering the abdomen the posterior layer of peritoneum covering the tumor is divided to the outer side of the colon, and the tumor separated from its attachments, cutting vessels between two ligatures, until the pedicle is reached; the latter is tied provisionally *en masse* and divided, and then its elements separately ligatured and the ureter specially treated as the case may require; or the renal artery may be tied through a separate incision before separation of the tumor is undertaken.[2]

In most instances it is found advantageous to perforate the lumbar region and to drain the site of the kidney tumor in this way, either by drainage-tube or by gauze.

The wound in the posterior layer of the peritoneum is next closed, the membrane wiped clean, and the wound of the anterior abdominal wall accurately sutured.

Puncture of the kidney is usually done for explorative purposes to determine whether an enlarged kidney contains fluid, and, if so, the character of the fluid. The position of the puncture may vary, but where possible should always be extra-peritoneal, and for this reason, except in very large tumors, should be made in the loin, with the patient in the usual semi-prone position.

Nephrotomy—incision of the kidney—is done for exploratory purposes, and for drainage either of hydronephrosis or of abscess of the kidney, and is always conducted through the loin.

The kidney may be exposed by any one of the lumbar incisions above described, but preferably by König's, especially in those cases in which the condition of the kidney is to determine the treatment of the organ itself.

Some trouble may be experienced in case the fatty capsule is much thickened or very closely adherent to the kidney; but patient dissection will usually suffice to separate the capsule, and in only exceedingly difficult cases is it necessary to split and peel off the fibrous capsule.

In any event, the posterior surface and external border of the kidney should be well exposed, and in the case of abscess the location of the pus should be sought by palpation, or by puncture at various points with the exploring needle; and the pelvis of the kidney should be examined to determine whether distention exists or not; for it is practically impossible to say in a given case whether the pus occurring in the urine is derived from the pelvis of the kidney or from an abscess of the gland itself.

If an abscess of the kidney be present, the overlying kidney tissue is incised at its thinnest point, and the finger introduced to explore the cavity and to locate any additional pockets or collections of pus; septa should not be broken down further than is necessary to ensure drainage, for all the renal tissue is of value: a drainage-tube is carried to the bottom of the cavity, and the external wound closed at its angles and packed at its center, where the drainage-tube emerges.

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[1] Abbe: *Ann. of Surg.*, Jan., 1894.

[2] Stimson: *Op. Surg.*, 3d ed., p. 478.

If distention of the pelvis of the kidney be present, or the pelvis of the kidney be found to contain calculi, the position of the incision of the kidney becomes of importance; and, while formerly the pelvis of the kidney was entered by an incision into its posterior surface or by an incision through the posterior surface of the kidney, to-day it is found that an incision into the pelvis of the kidney through its outer border possesses many advantages.[1]

Bleeding from such a wound is not generally so free as might be expected, and is quite readily controllable by gauze packing or by deep sutures.

In case drainage of the pelvis is desired, the tube is carried through the wound to the pelvis of the kidney, and the external wound treated as above indicated.

If, on the other hand, the pelvis contains one or more calculi and is free from suppuration, and more or less protracted drainage is unnecessary, after removal of the stones the kidney wound may be sutured, and then is found to heal very rapidly.

If hydronephrosis is the disease to be dealt with, and drainage is decided upon, in case the tumor is of considerable size the incision may be made farther from the spine than the outer border of the erector spinæ, but, at all events, the drainage-tube may be introduced at any convenient point, for in cases of any severity the kidney tissue is so thoroughly thinned and atrophied that no material destruction of it occurs through incision of any part of the sac. After evacuation of the sac and the insertion of the drain the external wound is sutured at its extremities and packed about the tube.

Nephro-lithotomy consists in the performance of nephrotomy for the removal of renal calculi, and for this purpose the kidney is exposed in the loin by the König incision, separated from its fatty capsule, and brought well down from beneath the ribs for examination.

The index finger is passed over its surface, and if at some point, generally paler than the surrounding tissue, the consistence indicates the presence of a stone, the overlying tissue is incised and the calculus extracted by proper forceps.

If, on the other hand, no stone is palpable, and repeated punctures of the kidney by a fine needle yield no information, it remains to explore the pelvis, either by incision directly into it, or indirectly by an incision through the convex border of the kidney; and of these methods the latter would seem to be preferable, not only because fistulæ are less likely to follow, but also because exploration of the cavity of the pelvis by this route is far more thorough and the damage to the calyces less extensive.[2]

The hemorrhage is often free, but may be prevented by digital compression of the artery or controlled by gauze pressure. The finger is then passed into the wound, and the pelvis of the kidney and its calyces thoroughly explored, and the stone, if discovered, removed, even if it has already descended for some distance into the ureter.

The stone having been removed, the wound of the kidney is united by deep and superficial sutures and the organ replaced, and the external wound closed with or without drainage.

If the stone be associated with abscess of the kidney, drainage of the abscess becomes the predominating feature, and the treatment is described under the head of Nephrotomy.

After drainage of the kidney or its pelvis for any cause, if the fistula persists and continues to discharge urine in any quantity, the condition is an exceedingly annoying one, and to relieve it a variety of procedures have been proposed and practised, largely dependent upon the permeability of the ureter and the state of the opposite kidney.

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[1] *Ann. des Mal. des Organ. genito-ur.*, June and July, 1891.

[2] Tuffier: *Études exper. sur la Chir. du Rein*, p. 88.

The permeability of the ureter may be judged roughly by the estimated quantity of urine escaping through the fistula, more accurately by cystoscopic inspection of the mouth of the ureter of the affected kidney, or by catheterization of the ureter.

If no urine finds its way into the bladder from the previously drained kidney, and the ureter is thought to be occluded, and the urine from the other one is found to be of fair quality, there would seem to be no good reason for not proceeding to nephrectomy, provided the patient's general condition will warrant so severe an operation; and the more so if at the original nephrotomy the kidney has been found so extensively disorganized as to possess but little secreting tissue.

On the other hand, if permeability of the ureter can be demonstrated and the kidney be in a fine state of preservation, every effort to close the fistula should be made before nephrectomy is resorted to.

Many such fistulæ close spontaneously within six months of operation: it happens occasionally that a calculus overlooked or inaccessible at the time of operation causes the persistence of a fistula, and then is found, as a rule, at the bottom of the tract, and may be easily removed.

But if no very good reason appears for the persistence of the fistula, its closure may be brought about by actively curetting or splitting it up, and by careful packing inducing healing from the bottom, and, only as a last resource, extirpating the kidney.

Nephrectomy—total removal of the kidney—is performed for certain injuries of the kidney or ureter, for tumors of the kidney that remain confined to the organ, for intractable renal fistulæ, for grave forms of suppuration such as surgical kidney, for tuberculosis, and, rarely, for floating or movable kidney; and under this heading, too, are included the cases of partial removal or resection of the kidney.

The experiments of Tuffier[1] have proven conclusively that after the removal of the whole or a part of a kidney the remaining kidney tissue is capable of carrying on the renal functions, and that it rapidly hypertrophies —so much so that in the course of a fortnight he was able to remove at repeated sittings an amount of kidney substance equal to the weight of the normal organs, without producing death.

The chief question to be decided before any contemplated nephrectomy, then, concerns the existence and condition of another kidney to perform the functions of both if either is extirpated; and this question ought to be determined with absolute certainty, for if an individual with but one sound kidney possesses only half the resources in the way of potential renal functionation of one with two, how much more badly off is he with but a single kidney, and that more or less damaged, even if the kidney in the latter case suffice to carry the patient through the crisis that inevitably follows nephrectomy!

The question becomes most grave when the congenital absence or rudimentary development of the kidney comes up for decision. However rare it may be, it is well known that congenital absence of the kidney does occur— 1 in 3992$\frac{2}{3}$ (Morris); and it is equally well known that persons have perished as the consequence of the removal of a single kidney.

There are, too, acquired conditions in which the secretion of urine is performed by one kidney alone, which must be excluded before nephrectomy can be undertaken.

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[1] *Études exper. sur la Chir. du Rein.*

Further, the possible presence of malformation of the kidney, particularly of fusion of the two kidneys or of misplacement of the kidney, demands the serious thought of the surgeon.

To establish the absence of all of these conditions requires most painstaking investigation. Abdominal palpation will many times serve to detect the presence of the kidney even when displaced, particularly if an anesthetic is used; and under favorable circumstances, as in case of thin and relaxed abdominal walls, malformations of the kidney have been recognized.

In other abdomens, however, palpation cannot be successfully carried out, and it is necessary to employ some other plan; and the digital exploration of the kidneys through a small incision in the linea alba has been practised many times with good result, especially in those cases in which abdominal nephrectomy is to be done.

But certain cases occur in which it is impossible to determine the existence of a second kidney, or in which it is impracticable, as in severe injuries, either from lack of time or facilities, or because extirpation of the wounded organ is imperative to prevent death from hemorrhage.

The cystoscope will show whether urine escapes from both ureteral orifices, but obviously this does not exclude the existence of fusion of the kidneys.

As to the determination of the state of the kidney not designed to be attacked much difficulty also presents itself. Kelly's method of catheterization of the ureters in the female is of immense value, but as yet no very generally applicable plan has been devised to obtain the urine separately from each kidney of the male unless by suprapubic cystotomy.[1]

In cases of renal fistula in which nephrectomy is to be performed because impermeability of the ureter exists the investigation becomes quite simple.

Finally, one should remember that some of the affections for which nephrectomy is occasionally performed are usually bilateral—*i. e.* cystic kidney.

The kidney may be removed through any of the lumbar incisions previously described, but König's is found most generally useful because of the maximum space afforded, and because by extending its horizontal limb the operation originally planned to be extra-peritoneal may readily be converted into an intra-peritoneal one.

The kidney or the tumor is exposed by teasing through the fatty capsule as usual; the next step consists in separating it from contiguous tissues by blunt dissection until the hilus and the pedicle are reached; the latter is provisionally tied *en masse* and the kidney removed, after which the renal artery and vein are separately ligatured and the ureter subjected to any further treatment required.

If the extirpation is done for renal fistula or for any condition in which thickening of the capsule or adhesion of the latter to contiguous parts exists, it is recommended to remove the kidney by shelling it out of its fibrous capsule, and leaving the latter, together with the fatty capsule, behind; indeed, in some instances it has been found impossible to remove all the kidney tissue—adherent, for example, to the vena cava—and portions of it have been allowed to remain.

Partial nephrectomy or resection of the kidney, where admissible at all, possesses the advantage of preserving more or less of the kidney tissue, and, although difficult of performance, has been done for certain injuries of the kidney, for some cysts of the kidney, and for benign tumors of either the gland itself or of its capsule, and at least once for sarcoma.[1]

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[1] The recent invention of a combination cystoscope and catheter makes it possible for the trained observer to catheterize the male ureters and obtain urine from the two kidneys separately.

The operation itself, as described by Tuffier,[2] consists in exposing the kidney through the loin and separating the fatty capsule completely to allow examination of the kidney on all sides, to facilitate its dislocation into the field of operation, and, equally important, to make digital compression of the artery possible during subsequent maneuvers.

The tumor and the affected portion of the kidney are next removed by an incision wide of the growth, and which may run 1 to 2 cm. from the hilus without danger, and which may open the pelvis.

Tuffier advises, then, that deep sutures of catgut be passed down to the mucous membrane of the pelvis, and reinforced by a few superficial stitches, and the constriction of the artery gradually relieved; in most cases no bleeding will occur, but, if it does, gentle pressure for a few moments, he says, will readily control it. The external wound is then closed with or without drainage.

Nephrorrhaphy, devised by Hahn[3] in 1881, consists in the fixation of a movable floating kidney in its normal position by sutures. Hahn exposed the fatty capsule of the kidney by a vertical incision in the loin, and sutured it to the margins of the wound, which was then packed and allowed to granulate. The result was not entirely satisfactory, so that in later cases the sutures were made to pass through the fibrous capsule and even the parenchyma of the kidney.

A great variety of detail has been introduced by different operators in placing the sutures, in suture material, etc., but the following method, described by Edebohls, will be found as satisfactory as any:

The patient is placed upon the table in the lateral position. Two small, firm pillows or cushions are so placed upon the table as to press into the lateral and anterior regions of the abdomen, crowding the viscera upward to the site of operation, and putting the latter well upon the stretch by separating, as far as possible, the twelfth rib from the crest of the ilium. The same antiseptic and aseptic precautions are observed as at a celiotomy. The incision, made along the outer edge of the erector spinæ muscle, should in all cases extend the entire distance between the lower edge of the twelfth rib and the crest of the ilium. It should be made more or less oblique according to the lesser or greater distance between these points. The superficial fat, the tendon of the latissimus dorsi, and the conjoined tendon of the internal oblique and transversalis are successively divided along the whole length of the cutaneous incision until the perirenal fat is reached. The outer fibers of the quadratus lumborum occasionally overlap the line of incision, and are then cut through along their length. The fatty capsule is penetrated by a small incision until the kidney with its capsula propria is detected at the bottom of the wound. Palpation of the kidney with one or two fingers through the wound of the fatty capsule will enable us to get our bearings and determine the extent to which the length of the incision in the fatty capsule should be increased in both the upward and downward directions. The fatty capsule is incised along the whole length of the convexity of the kidney, after which it is drawn out of the wound as far as it will go, and the redundancy of the fat-sac is cut off on either side at a level with the bottom of the wound.

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[1] Abbe: *Ann. of Surg.*, Jan., 1894.

[2] *Ann. des Mal. des Organes genito-urin.*, Dec., 1895.

[3] *Am. Journ. Med. Sci.*, Mar. and Apr., 1893.

In doing this care must be exercised not to open the peritoneum at the lower pole of the kidney. The trimmed edges of the fatty capsules are secured with a small pair of T-shaped forceps for guidance in the subsequent suturing. The delicate part of the work now begins. The capsula propria of the kidney is incised along the whole length of the convexity of the organ in the mesial line. To do this successfully the kidney must be moved up and down so as to expose successively, at the bottom of the wound, the lower and upper halves of the organ. A pair of tenaculum forceps or two are of material aid in this and the subsequent parts of the operation. They must, however, be used with exceeding gentleness, as the kidney substance is exasperatingly friable, and they readily tear out. During this and subsequent steps of the operation it is of paramount importance that the kidney be pressed well into the bottom of the wound, so as to be readily accessible. If the two cushions spoken of at the beginning have been well placed under the left loin, nothing further is generally necessary, the kidney being well sustained in place, merely moving rhythmically upward and downward with respiration. If the cushions are not properly placed or prove insufficient, the hand of an assistant pressing upon the abdomen so as to crowd the kidney into the wound must be made to take their place or to supplement them. After the capsula propria has been incised it is stripped off from the kidney substance on either side until about 1¼ cm. of the kidney substance are exposed on either side along the whole length of the incision through the capsule, thus making raw a surface 10–12 cm. long by 2½ cm. wide for union with the deep parts of the lumbar incision. It is just here where nephrorrhaphy performed by stitching the fatty capsule alone, or by stitching the kidney without opening its capsula propria, has failed, both the fatty capsule and the capsule proper being tissues in no way adapted to firm cicatricial union with contiguous parts. The stripped-off capsula propria is not removed, but is doubled backward upon the still adherent portion like the lapel of a coat.

Thus far, the steps of the operation have been identical in all my cases. In the method of suturing, however, I have made slight variations. At first the writer sewed with silkworm gut, embracing on either side, in each suture, skin, superficial fat, the tendons of the abdominal muscles, the cut and trimmed edges of the perirenal fatty capsule, the reflected as well as the still adherent capsula propria. The loop of the suture penetrated the kidney substance to the depth of 1–1½ cm. Five or six such sutures were usually passed and tied upon the skin, after a rubber drain had first been passed to the bottom of the wound and caused to lie along the raw kidney substance its whole length, with an end emerging at either angle of the wound. In later cases he attached the kidney to the deeper and firmer tissues of the abdominal walls, the muscles, and aponeuroses by buried sutures of kangaroo tendon or silkworm gut, passing a drain composed of ten or twelve silkworm strands along the raw kidney surface, instead of the rubber drain. The purpose of the drain is twofold: first, to remove from the depths of the wound all secretions which might interfere with primary union; and secondly, to favor firm cicatricial union by mild irritation of the raw kidney substance and the contiguous deep tissues of the abdominal wound. In tying the deep buried sutures, whether of silkworm gut or of kangaroo tendon, care must be exercised not to draw them too tightly, as they readily cut through the friable kidney substance. The skin and superficial fat are closed over the deep buried sutures by a running suture of catgut. Union by first intention has been the rule. The dressings are changed for the first and last time on the eighth day, when the drain is removed. The patient is kept upon the back for three weeks, and then allowed to sit up and go about as she pleases.

Accidents.—Any operation upon the kidney through the loin may be complicated by wounds of the pleura, and, although this accident is usually not serious, it may become so if the pleura is inoculated by infectious pus.

It is extremely advisable, as a preliminary to all operations upon the kidney, to count the ribs, and thus eliminate the possibility of wounding the pleura that follows mistaking the eleventh for the twelfth rib.

Should the pleural cavity be opened, however, the wound must be blocked by a bit of gauze or sponge at once, and then closed by a continuous suture of fine catgut.

Wounds of the peritoneum are dangerous at times for the same reasons, and must be managed in the same way.

Profuse bleeding occurs from the wounded kidney tissue occasionally, but is usually arrested by gauze pressure maintained steadily for a few moments.

Bleeding from the vessels at the hilus only occurs as the dissection approaches this region; it is severe, and can only be controlled by clamping the bleeding vessel.

Hemorrhage from the rent in the vena cava has always proved fatal, either at once or subsequently as the effect of thrombosis or embolism; but it is at least conceivable that a lateral ligature or suture might be applied to a wound of moderate size in the vena cava.

The shock of kidney operations, particularly of nephrectomy, is sometimes severe, and appears to be exaggerated in those cases in which the remaining kidney is not entirely sound.

After operations upon the kidneys, and especially nephrectomy, the kidney is usually acutely congested, and in addition, in the latter case, the kidney tissue available for secretion is much diminished; therefore, it is not surprising that a considerable reduction in the volume of urine secreted occurs, or that the urine should contain more or less blood and albumin. But in most cases this condition is transitory, and after a few days the amount of urine increases, and becomes normal as the congestion subsides and hypertrophy of the functionating kidney occurs.

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